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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Quantity Production in Europe.

Undoubtedly the most important Paper presented to the recent Congress was the American Foundrymen's Association Exchange Paper, entitled "Quality in Quantity," by Arnold Lenz, as it opens up the question whether it is possible to produce under mass-production methods an article comparable with that made by hand-moulding methods. This question can be answered by placing the pattern for any automobile cylinder in a jobbing foundry which has not specialised in this class of work. No matter how clever the moulding staff, the result would not be as good as that turned out with almost monotonous regularity in an automobile foundry. If thousands of castings are being made from a single pattern, then research work can be carried out on every possible phase of the work. A certain piece of apparatus with which we are familiar requires for its operation the movement of a lever by a rush of water. This lever has been protected against corrosion from all types of water. What chance of success would it have if but a few were made? It is only by a heavy quantity production that this one point can be solved. The bugbear of wasters which can be so formidable as to ruin the jobbing shop becomes of infinitely less importance in the quantity-production shop. For instance, four successive wasters on the production of a turbine casing would embarrass most firms, yet a large American foundry, making many large fortunes annually, can afford to carry 25 per cent. wasters on its automobile cylinders. But when moulds are made so rapidly their cost is negligible, and obviously the question arises as whether we in Great Britain can with profit emulate American practice. Primarily, there does not exist the hundred million inhabitants, speaking the same language, having similar tastes, and devoid of customs barriers. Britain is certainly associated with large and prosperous overseas dominions, but unfortunately they possess very different climatic conditions, a different mental make-up, a strong desire to manufacture locally, and varying industrial conditions. To find materials which will satisfy all these conditions is difficult but not insuperable. To cite but one instance, there is the provision of cast-iron pipes, which, if made in sufficiently large quantities, should be capable of entering satisfactorily every market existing within the bounds of what is known as the British Commonwealth of Nations. Another is cast-iron telegraph poles, which should be equally satisfactory both at home and abroad. Electrical fittings, gas fittings, and similar work, too, should be universally applicable, whilst we see no reason why the castings comprised in the designations "builders' castings" and "corporation castings" could not be made so cheaply that neither architect nor public official could lightly impose their pet designs and prejudices without taking due cognizance of the advantages offered by the quantity-produced article. Those progressive foundrymen who have a clear realisation of the truth of this hypothesis would do well to investigate the potentialities of some of the many modifications of the permanent mould, as represented by die casting, centrifugal casting, and refractory non-adhering mixtures, for it is patent that it is basically gross extravagance to make up a mould for one casting only.

D

Making Rolls from Semi-Steel.*

By F. L.

The manufacture of cast iron rolls at the writer's works is fairly important, as it has to assure the continuous working of six trains, including a pair of blooms It was based, before the adoption of the method set out below, on charging into the cupola a mixture of hematite or phosphoric iron, remelted iron, light steel scrap, spiegel, basic pig, etc., in a proportion which was designed to give approximately the following analysis:—Si, 0.4 to 0.6; Mn, 0.6 to 1.0; S, < 0.100; P, 0.250 to 0.450; and total C. 2.5 to 3.0 per cent. It was easy enough to obtain the first four elements in the proportions indicated, but it was definitely impossible to obtain a sufficiently low total carbon content, and it was very rarely lower than 3.2 per cent. On machining, all the rolls, and particularly those exceeding 400 mm., cut very "soft," and gave turnings lacking consistency, exceptionally powdery, and blackening one's fingers very much. After examination, the outside surface was pin-holey, and, to use an expression seldom heard, one would have thought drops of rain had fallen on the roll, each drop having, where it fell, browned the surface of the casting. These brown marks, formed from graphite aggregations, under working conditions, are very easily detached by either quick working or variations in the temperature of the metal, whether it be either ingots or billets, and its hardness. Numerous tests were carried out in respect to the composition of the charges, the using of remelted and pigged scrap, without any addition of steel, basic pig, and spiegel; the temperature of metal in the ladle; the rapid cooling of the mass, etc.; these did not give any clear improvement, and the works were on the point of owning themselves beaten, when a trial of a mixture of scrap put them on a new track, raised new hopes, and briefly the events leading to this were: The works staff, having to furnish an iron of less than 2.5 total carbon, could not obtain it in the plant available, and had, therefore, to go to the foundry to make a last trial of melting in the cupola 50 per cent. of light steel with 50 per cent. of hematite iron containing 4 per cent. total carbon. The trial proved a complete failure; the total carbon was over 3.4 per cent., and the sulphur reached 0.143 per cent. It should be understood that the cupola was a deplorable contraption, the height of the tuyeres to the throat being 3.1 times the diameter, and was slow in working; again, the coke used was of blast-furnace quality, very often containing a considerable proportion of dirt. Also, the steel scrap was nondescript and very small. It might have been successful as far as the total carbon was concerned if the sulphur had not been so strongly taken up. Whilst 0.05 per cent. was specified, actually there was 0.143 per cent. In short, the recarburation was too great—much greater than the mixture, which gave theoretically 2.10 total carbon. Such a mixture has a great affinity for carbon, and it tended to reach the normal content of 3.5 to 4 per cent. total carbon. Moreover, the slowness of melting left the bad coke too long in contact with the metal, and considerable sulphurisation resulted. This set-back suggested mixing liquid iron and liquid steel in the ladle to give a predetermined composition. This mixture, when carefully slagged, in order to increase the chance of homogeneity, was cast into pigs, which were very strong. They were of the composition specified by the client, and it gave him entire satisfaction. This success suggested the use of a mixture of liquid iron and steel for rolls, and there was no hesitation in trying it on an 8-ton roll. The works were convinced that, apart, perhaps, from the question of homogeneity, it would be a success.

The cupola gave a metal analysing: Si., 0.8; Mn, 1.2; S, 0.09; P, 0.30; and total C, 3.8 per cent.

Five and a half tons of this metal was mixed with 3 tons of acid siemens, of medium temper, in order to obtain the following composition:—Si, 0.52; Mn, 1.05; S, 0.084; P, 0.220; and total C, 2.7 per cent.

Before pouring, the metal was carefully slagged and stirred with a steel bar. A second roll of the same train, but of less weight (about 6½ tons), was cast under the same conditions, and gave the following analysis:—Si, 0.58; Mn, 0.62; S, 0.050; P, 0.210; and total C, 2.32 per cent.

The total carbon content problem was then deemed to be solved.

Machining the Rolls.

The turning of rolls cast under the conditions set out above were quite satisfactory, and the metal tooling went very well. The turnings obtained from the first cut were not powdery, as in the case with the iron containing 3.3 to 3.6 per cent. total carbon and cut "fat," to use words of the turner. After finishing, the surface appeared bright without greyish spots, and the turnings all along the width of the tool rolled themselves into cigarettes. This is considered to be almost an infallible sign of a good roll. The fracture was of the "pepper and salt" variety, and was infinitely more reassuring than those previously made.

Conclusions.

So far as the works were concerned this method offered two real advantages, which are:—(1) Elimination of thrice melted metal for the casting; and (2) increase of the hardness of the rolls, which brings in a reduction of redressing cost, arising from wear during rolling.

Thrice melting is mentioned because the cupola, having the characteristics outlined, it was practically impossible to obtain a homogeneous metal by melting one or several types of hematite or phosphorus iron with spiegel (for adding Mn); with basic pig (for adding P); and with steel scrap (for lowering the Si and total carbon contents). Obviously, pigs had to be made from two meltings, then be remelted for final casting. The works can now start off with a semi-phosphoric iron of the following composition:—Si, 1 to 1.2; Mn, 0.7; P, 0.5; and total C, 4.0 per cent., to which is merely added some spiegel when charging, or with a hematite iron analysing:—Si, 1 to 1.2; Mn, 0.7; P, 0.10; and total C, 4.0 per cent., to which an addition of spiegel and basic pig is necessary.

The works are now convinced that a mixture of liquid steel, and once-melted iron of suitable composition, will give good reliable results, and at a very advantageous cost.

* Translated from "La Fonderie Moderne."

A New House Organ.

Messrs. Spear & Jackson, Limited, of Aetna Works, Sheffield, is the latest firm to have its own house organ. Called after their well-established trade mark, "The Mermaid," the publication is to appear quarterly. Whilst the primary object is the furthering of their important business in saws, a certain amount of lighter material has been introduced, and, unlike so many efforts of this type, is quite acceptable. It is devoid of advertising matter, and contains 32 well-illustrated technical pages. On the metallurgical side, an article by Mr. F. F. Gordon deals with crucible steel-melting process. Neither mixtures for the crucible nor the percentage of coal-dust used is given, so we gather the object is to interest non-technical people. The dozzle used for reducing piping in the ingot is invariably heated, though again this is not stated. We would remind the publishers that there is now a close liaison between the foundry and the pattern shop, and the appreciation of the nature of the tools used by these two sections of the metallurgical industry is increasing. Thus in this case it would be well to give some metallurgical reasons for the rationale of steel-works processes. We wish "The Mermaid" a long and useful career.

SIR J. C. DAVIES, managing director of Baldwins, LIMITED, has returned to London after a brief visit to America.

INSTITUTE OF BRITISH FOUNDRYMEN.

TWENTY-THIRD ANNUAL CONVENTION.

The twenty-third annual convention of the Institute of British Foundrymen, under the presidency of Mr. V. C. Faulkner, was held in London from June 15 to 19, 1926, coincidently with the International Foundry Trades Exhibition, which latter was held at the Royal Agricultural Hall from June 10 to 19. Conferences were held on June 16 and 17 at the Royal Agricultural Hall, and during the week those attending the Convention were afforded opportunities for inspecting a large number of works around London. The Convention opened with a reception at the Spring Gardens Gallery, Spring Gardens, Trafalgar Square, on Tuesday, June 15.

A feature of the Convention was the large number of foreign delegates who attended.

WEDNESDAY, JUNE 16.

The business of the Convention opened on Wednesday, June 16, when the members and delegates were welcomed by the Rt. Hon. Arthur Henderson, P.C., M.P.

MR. J. CAMERON, J.P. (the retiring President of the Institute), who presided at the opening of the proceedings, introduced Mr. Henderson, whom, he said, was a real foundryman, having been a moulder for a number of years.

MR. ARTHUR HENDERSON said it afforded him unqualified pleasure to welcome sincerely the members of the Institute and the delegates to the Convention. After some amusing speculations as to the reason why he had been asked to extend a welcome to them, he said he had come to the conclusion that the reason why the Convention Committee had conferred that honour upon him was that he himself was a product of the iron foundry—(applause)—and that, before he had devoted so much of a very long public life to the moulding of public opinion, it had been his business to mould castings. In fact, in foundry parlance, he was a "sand rat," or, in the more polite language of the present day, an "artist in sand." He had been interested to learn that morning that the chain of office worn by the President had been presented to the Institute by one who had been his foreman in the foundry, namely, Mr. W. Mayer (a past-President), probably one of the most capable men in the iron-founding industry that he had ever met. All these facts had added to the pleasure which his presence at the Convention had afforded him. Dealing with the aims and achievements of the Institute of British Foundrymen, he said that in his judgment its greatest importance lay in the fact that it was concerned with the welfare of an important industry, and aimed at the academic, technical and practical improvement of its members. In these days rule-of-thumb, haphazard, hand-to-mouth methods of conducting business or trade could not possibly lead to success. One of the drawbacks for which the large-scale use of machinery in industry was responsible was that it tended to restrain the free play of individuality, and sometimes failed to provide the men engaged in industry with the opportunities for becoming real artists. All good workmanship was art; in all occupations there should be room for good workmanship, and the fullest inducements should be offered for its encouragement. How profoundly true it remained that many workmen connected with modern industry were no longer permitted to express those instincts and impulses which gave the craftsmen of earlier years so much pride and satisfaction in their work, that feeling of profound satisfaction which a workman derived from the consciousness that he had produced an intrinsically beautiful thing by his own hands. The only satisfaction which many workmen enjoyed in these days was that of knowing that they had performed a mechanical or routine task as well as it could be performed. Surely it must be admitted that this process had had to some extent a demoralising effect. It checked the development of personality, it discouraged the study of technical subjects, and it prevented the growth of a legitimate ambition to foster and maintain the status of craftsmanship. It was the work of the Institute of British Foundrymen to prevent, by proper education, the deterioration to which he had referred. Moreover, the increasing difficulties and complications of industrial and commercial life demanded from all classes of officials and workmen the highest standard of education, and unless care was exercised, the amazing development of mechanical inventions, standardisation and mass production might lead to a more complete servitude and subordination of the man to the machine. To the American visitors he would say—without wishing to be in the slightest degree critical—that the one thing which had impressed him more than any other during a visit to the United States at the end of last year was this danger. He had seen the system of repetition and mass production made so perfect that he could not but exclaim that in that system the man was supplementary to the machine and the automatic process instead of the machine and the automatic process being supplementary to the man. In modern history we should aim not only at raising the standard of intelligence but of developing the latent forces of character and of personality. In saying this he did not for a moment deny the utilitarian significance of education, but wished to emphasise that in many respects we were still technically an ill-educated people, and the stage had probably been reached in our economic development when failure to achieve more efficient education on the lines he had suggested might lead, not to progress, but to retrogression. Moreover, it could not be denied, having regard to the keenness of the competition of the age, that a higher standard of education was absolutely essential in any producing country

MR. V. C. FAULKNER

(the recently elected President of the Institute of British Foundrymen).

Mr. Faulkner was trained in the metallurgical department of Sheffield University under Dr. Arnold. After spending a few years in the laboratories of Messrs. Hobson, Houghton & Company, and Vickers, Limited, he became interested in the manufacture of electric steel, being associated successively with the Stobie Steel Company; National Steam Car Company, Limited; Electro Metals, Limited, and Watson's (Metallurgists) Limited. Work in this connection involved long periods on the Continent supervising the starting up of the furnaces. Mr. Faulkner was appointed Editor of THE FOUNDRY TRADE JOURNAL on its change to a weekly publication 5½ years ago. He was recently elected President of the Foundry Trades Supply and Equipment Association. He is also a member of the Iron and Steel Institute, the Institute of Metals, and the French and American Foundrymen's Associations.

if that country were to keep abreast of its competitors. He offered his sincere congratulations to the Institute because of its educational efforts, so vital to the economic and even to the spiritual development of its members.

Referring to the system of presenting exchange papers on technical foundry problems written by the representatives of different countries, and the fact that there were present a large number of representatives from various countries, he said that papers were to be read at the Convention by authors in America, France and Belgium, and that since the idea of exchanging papers between the different countries had been inaugurated more than fifty papers had passed. This was all to the good. No longer could trade and commerce be regarded as a local or even a national concern, and for that reason he extended, on behalf of the members of the Institute, a hearty welcome to the foreign delegates present. Trade, he said, was world-wide. Our raw materials flowed into this country from the remotest parts of the earth: our food was grown under foreign skies; and the products of our mills, factories and workshops were used by the peoples of every land. The earth was a store-house, and all the nations of the earth were our customers. Recent years had witnessed a serious and unprecedented disturbance of the economic balance between nations. Every country was now striving, and rightly so, to concentrate its productive energies upon the recovery of lost ground, seeking, by increased production, to become again prosperous, stable and secure. Having regard to these things, surely he was right in saying that any Institution that brought men together for the pooling of their ideas, the interchange of their views, the removal and avoidance of misunderstandings, and the strengthening of ties of friendship, deserved every encouragement. Therefore, he had the greatest possible pleasure in extending, not only to the members of the Institute, but to visitors from overseas, a most sincere welcome, and expressed the hope that their deliberations would be highly successful.

Presentation of the "Oliver Stubbs" Gold Medal.

The Oliver Stubbs Gold Medal, awarded for outstanding work on behalf of the foundry industry, was presented to Mr. A. R. Bartlett (Past-President of the London Branch).

MR. CAMERON paid a tribute to the distinguished work which Mr. Bartlett had done in connection with the industry, and said that he was indeed a worthy recipient.

MR. HENDERSON presented the medal, and said he had no doubt in his own mind that it was the reward of real merit.

MR. BARTLETT, returning thanks for the honour conferred upon him, said that in connection with the work he had tried to do for the benefit of the Institute and the industry he had not been influenced by self-interest. That work had been done, for the most part, before the Oliver Stubbs Medal was instituted, and he assured his hearers that in the future, as in the past, he would endeavour to impart his knowledge and experience to his fellow-members in the Institute and the trade.

Vote of Thanks to Mr. Henderson.

MR. OLIVER STUBBS (Past-President of the Institute) proposed a vote of thanks to Mr. Henderson for having extended a welcome to the members and delegates, and for having delivered such an excellent address. Mr. Henderson's career, he said, was an example of what one could do if one tried, and he hoped that other members of his Trade Union Executive would emulate his example and accept invitations to attend the conferences of the Institute. The members of the Institute were anxious to develop and maintain good-fellowship, and so clear away some of the troubles that existed at present.

MR. V. C. FAULKNER (President Designate), seconding, said that the Institute was deeply indebted to Mr. Henderson because he felt sure that when his message reached the foundrymen of Great Britain they would take a great deal of notice of it, and would be able to enter the ranks of the Institute with the knowledge that their great leader had said they should do so.

MR. CAMERON, supporting the vote of thanks, also expressed indebtedness to Mr. Henderson for his thoughtful address and for the welcome he had extended to the members. He thanked him for having appreciated so exactly what the Institute really stood for, *i.e.*, to make the craftsman proud of his craft and of his work, and to encourage those social meetings and interchanges of experience which were so valuable.

Mr. Henderson Elected an Honorary Life Member.

MR. CAMERON then proposed that the Institute should honour itself by electing Mr. Henderson an honorary life member.

The proposal was greeted with enthusiasm, and Mr. Henderson was unanimously elected.

MR. HENDERSON, expressing his appreciation, said that no greater reward could come to a public representative than the spontaneous expression of thanks to which the members of the Institute had given utterance. He had been honoured in being permitted to be present; he had renewed old associations, and had felt that he could not resist the invitation extended to him. Speaking of the sixteen years which he had devoted to foundry work, he said that during the whole of his career he had never regretted it. It had certainly given him a knowledge of a very important trade, and had brought him into close contact with the working classes, whom he tried so hard to benefit during the later years of his life. He would be glad to exercise any influence he might have upon his fellows in the iron-founding industry and the members of the organisaton whose official he had been for 42 years out of 43 years of membership. For 23 years he had represented the moulders in the House of Commons, and that was one of the achievements that he valued highly. It was out of the moulders' union that his opportunities had come, the members of that union having invited him to become a Parliamentary candidate in 1902. In 1903 he was sent to the House of Commons as their representative.

The Annual General Meeting.

The business of the annual general meeting was then proceeded with.

The minutes of the last annual general meeting, held in Glasgow on June 10, 1925, were read, confirmed and signed.

The annual report of the General Council for the session 1925-26, and the accounts for the year ended December 31, 1925, were adopted by the meeting without discussion.

ANNUAL REPORT OF THE GENERAL COUNCIL.

The General Council have pleasure in presenting to the members their Report of the progress and work of the Institute during the past Session, 1925-26.

Three General Council meetings have been held during the session at York, London and Birmingham respectively. Representatives of the Branches from all parts of the country have attended the meetings, and there has been an average attendance of twenty-six.

The respective Branches have the following members attached:—

	Members.	Associate Members.	Associates.	Total.
Birmingham, Coventry, and W. Midlands	72 (48)	122 (81)	22 (14)	216 (143)
East Midlands	31 (32)	52 (54)	5 (8)	88 (94)
Lancashire	103 (105)	187 (197)	8 (9)	298 (311)
London	92 (75)	77 (68)	10 (12)	179 (155)
Newcastle	76 (80)	72 (86)	88 (76)	236 (242)
Scottish	50 (54)	112 (114)	30 (26)	192 (194)
Sheffield	83 (85)	89 (88)	11 (12)	183 (185)
West Riding of Yorks.	28 (34)	45 (50)	2 (—)	75 (84)
Wales and Mon.	18 (19)	12 (12)	3 (—)	33 (31)
Middlesbrough	19	19	7	45
General	26 (47)	3 (44)	— (4)	29 (95)
	598 (579)	790 (794)	186 (161)	1574 (1534)

The figures in brackets are for the Session 1924–1925.

The total number of members on the roll of the Institute on April 30, 1926, was 1,574. The members will be pleased to learn that a new Branch has been opened at Middlesbrough, which promises to be very successful, and the Birmingham and Coventry Branches have now joined forces under the title of the Birmingham, Coventry and West Midland Branch. The Council regret to have to report that six deaths have taken place during the year.

The members would learn with regret of the death in July last of Mr. T. H. Firth, who was President of this Institute in 1918. Mr. Firth was also a trustee and took a very keen interest in everything appertaining to the welfare of the Institute.

Annual Conference, 1926.

This will be held on June 16, 17, 18 and 19 at the Royal Agricultural Hall, Islington, London, N.1, by the kind permission of Messrs. F. W. Bridges and Sons (organisers of the Foundry and Allied Trades Exhibition). Programme of the Conference arrangements is included in this booklet.

"Oliver Stubbs" Gold Medal.

The fourth medal was awarded to Mr. A. Campion, of the Scottish Branch, for meritorious services rendered to the Institute over a period of many years.

MR. JOHN T. GOODWIN
(Senior Vice-President).

Mr. J. T. Goodwin, who was born on May 3, 1877, was general manager of the foundries and engineering departments of the Sheepbridge Coal & Iron Company, Chesterfield, which position he has held for the last 18 years. During the war he erected a new factory for the complete manufacture of shells for the Admiralty up to 15-in. diameter, and delivered over 10,000 tons of various shells, bombs, depth charge throwers, etc., and 20,000 tons of castings to Government requirements. He was captain of the Northern Command of the Derbyshire Motor Transport Corps, and in recognition of his services he received the M.B.E. at Buckingham Palace in 1918. He has been a member of the I.B.F. since 1905, and was on the Reception Committee upon their visit to Middlesbrough in 1907. He was actively connected with the Sheffield branch up to the middle of the war, giving several Papers. He is a member of the Council of the B.C.I.R.A., and is a member of the Institution of Mechanical Engineers, the Cleveland Institute, the Institute of Metals, and the Iron and Steel Institute.

Diplomas.

These have been awarded to the following for Papers read at meetings:—D. Wilkinson, Birmingham; J. W. Frier, Newcastle-on-Tyne; H. Jowett, Burnley; F. C. Edwards, Birmingham, for Paper read before the East Midlands Branch.

General Council.

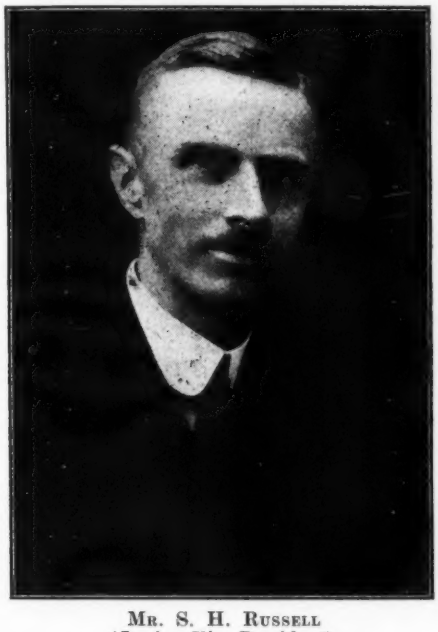
The members who retire in accordance with the rules are: Messrs. A. R. Bartlett, Wesley Lambert, H. Pemberton and J. Shaw. Messrs. A. R. Bartlett, Wesley Lambert, H. Pemberton and J. Shaw offer themselves for re-election. Four members will require to be elected at the London Conference to complete the ten members as provided for in the bye-laws.

Standardisation of Test Bars.

Your committee have not met during the year on account of the B.E.S.A. not having concluded its sittings. It may now be taken for granted that most of the clauses set forth in the I.B.F. tentative specification will be adopted. The chief outstanding point is the proposal that the bars be geometrically proportional. This, while scientifically correct for a homogeneous material, does not hold good for a metal like cast iron. It is quite probable that before the Conference is held that difference of opinion will be over. Once the B.E.S.A. agrees to accept a specification the way will be open for your committee to meet and submit proposals for the International Convention to be held at Detroit in September next.

British Cast Iron Research Association.

The past year has been a very momentous one in the history of the Association. It was reported in the last conference programme that a laboratory had been acquired in which certain investigations and tests could be conducted.



MR. S. H. RUSSELL
(Junior Vice-President).

Mr. Russell is a partner in S. Russell & Sons, Bath Foundry, Leicester. He has served for many years on the Council of the Institute, and has acted as President of the East Midlands Branch. He is a very active member of the British Cast Iron Research Association.

During the past year an amalgamation has been effected between the Association and the Foundry Technical Institute, Falkirk, which provides the Association with laboratories in Scotland, and with a group of new members in the important light castings section of the industry. The Association has made considerable progress with its research programme and the number of members during the year has also increased considerably, some of the new members being of an extremely influential character.

The five-year period during which the Association was guaranteed support by H.M. Government expires in June next, and pursuing its usual plan in such cases the Government set up a small expert and impartial committee to make a thorough examination of the work of the Association at all places where work was being carried out, both at the headquarters offices, the laboratories at Birmingham and Falkirk, and at the universities and national institutions where research work is done. The report prepared by the inspectors has been transmitted by the Department of Scientific and Industrial Research to the Association, and this is a confidential document not for publication. It has been circulated to the members, and any founder seriously contemplating membership will be forwarded a copy on application.

It can, however, be said that the report is of such a highly favourable character that the department has had no hesitation in asking the Government to continue its support for a further period of five years on exceptionally favourable terms, and have been so

arranged to make it advantageous for the Association to get the maximum possible support from the industry. Every development which has taken place since the Association was organised on a stable basis has received the cordial approval of the inspectors and the department, and the council now feels that the Association is on a permanent and stable basis and can look forward to a highly promising future. The council, therefore, confidently hopes that with the improvement of trading conditions membership will be extended among all producers of grey and malleable iron, whether engineering works or jobbing foundries, and also on the part of the blast furnace plants producing foundry pig-iron.

The annual subscription for the services rendered is extremely small, and is the sole charge made by the Association. It can be treated by member firms as a business expense not subject to income tax. The Association expends solely for the benefit of members some £8,000 per annum.

American Foundrymen's Association.

It is anticipated that a large delegation will attend the second International Foundrymen's Congress at Detroit, U.S.A., next autumn. About twelve European countries will be represented. Exchange Papers will be presented by the Foundry Associations of Great Britain, France, Belgium, Germany, and Czecho-Slovakia. Nearly sixty American foundries have offered to open their works for inspection by the foreign delegates.

JOHN CAMERON, *President.*
W. G. HOLLINWORTH, *General Secretary.*

The accounts and balance sheet are presented herewith:—

Balance Sheet.

INCOME & EXPENDITURE ACCOUNT.

EXPENDITURE.	£ s. d.	£ s. d.
Postages		87 2 0
Printing and Stationery, including Printing of Proceedings		513 0 7
Council, Finance and Annual Meeting Expenses		48 17 7
Illuminated Address		10 10 0
Branch Expenses—		
Lancashire	£112 2 9	
Birmingham	102 18 6	
Scottish	88 4 11	
Sheffield	91 11 1	
London	47 5 7	
East Midlands	24 5 10	
Newcastle	78 14 1	
West Riding of Yorkshire	15 3 1	
Wales and Monmouth	26 16 2	
		587 2 0
Audit Fee		6 6 0
Incidental Expenses		17 7 0
Salaries—Secretary and Clerk		400 0 0
Rent of Office		65 0 0
Depreciation of Furniture		8 10 9
		£1,743 15 11

INCOME.	£ s. d.
Subscriptions Received	1,677 2 6
Sale of Proceedings, etc.	6 11 6
Interest on War Loan and Cash on Deposit	32 15 10
Surplus Surtees Memorial Fund	10 1 4
Surplus from Coventry Branch	3 15 9
	£1,730 6 11
Excess of Expenditure over Income	13 9 0
	£1,743 15 11

LIABILITIES.	£ s. d.	£ s. d.
Subscriptions paid in advance		120 14 6
Sundry Creditors		315 18 7
The Oliver Stubbs Medal Fund—		
Balance from last Account	206 18 8	
Interest to Date	8 13 4	
	215 12 0	
Less: Cost of Medal	9 10 0	
		206 2 0
Surplus at December 31st, 1924	999 14 6	
Less: Excess of Expenditure over Income for the year ended December 31st, 1925	13 9 0	
		986 5 6
		£1,629 0 7

ASSETS.	£ s. d.	£ s. d.
Cash in Hands of Secretaries—		
Lancashire	5 8 4	
Birmingham	7 5 10	
Scottish	0 12 7	
Sheffield	72 18 9	
London	53 1 6	
East Midlands	32 14 7	
West Riding of Yorkshire	28 17 6	
Newcastle	5 2 10	
Wales and Monmouth	5 3 10	
		211 5 9
Lloyds Bank, Limited—		
General Account	302 6 3	
Deposit Account	400 0 0	
		702 6 3
Oliver Stubbs Medal Fund—		
£342 5s. 7d. Local Loans £3 per cent. Stock at cost	200 0 0	
Balance in hands of Lloyds Bank, Ltd.	6 2 0	
		206 2 0
Investment Account—		
£100 5% National War Bonds, £350 5% War Loan at Cost		432 10 1
Furniture, Fittings and Fixtures		
Per last Account	85 7 3	
Less: Depreciation 10%	8 10 9	
		76 16 6
		£1,629 0 7

We have prepared and audited the above Balance sheet with the Books and Vouchers of the Institute and certify same to be in accordance therewith.

(*Signed*)
J. & A. W. SULLY & Co.,
Chartered Accountants,
Auditors.

Induction of the New President.

MR. CAMERON, in handing over the office of President to Mr. V. C. Faulkner, said how much he had enjoyed the trust which the members of the Institute had imposed upon him during the past year. He had tried to do his best to maintain the traditions of that office. During the year he had visited nearly all the Branches of the Institute, and had been fortunate, as few Presidents had been fortunate, in having a most harmonious and splendid Council to work with. In handing over the office to his successor, he said that Mr. Faulkner came eminently qualified to hold such a position; he was a trained metallurgist, an expert journalist, and had made his mark in the foundry industry. As Editor of THE FOUNDRY TRADE JOURNAL he had made that paper a success; indeed, he had made such a success of it that it was absolutely indispensable to every up-to-date foundryman to-day. That was due to Mr. Faulkner's ability and his enthusiasm for the foundry business.

MR. FAULKNER then assumed the chain of office and formally occupied the chair, amid prolonged applause. He expressed his deep consciousness of the honour conferred upon him, and of the work the office involved, but expressed the hope that when industrial conditions settled down the Institute could look forward to a prosperous year. He knew he would have the full support of the Past-Presidents and Vice-Presidents.

The New Vice-Presidents.

Mr. J. T. Goodwin and Mr. S. H. Russell were unanimously elected Senior and Junior Vice-President respectively. The election of Mr. Goodwin was proposed by the President and seconded by Mr. R. O. Patterson (Past-President); that of Mr. Russell was proposed by Mr. Goodwin and seconded by Mr. F. J. Cook (Past-President).

Members of Council.

The result of the ballot for four members to serve on the general Council, to fill vacancies caused by retirement, was the re-election of the following:—Mr. A. R. Bartlett (London), Mr. Wesley Lambert (London), Mr. H. Pemberton (East Midlands), and Mr. J. Shaw (Sheffield).

Trustees.

On the proposition of Mr. G. E. Roberts, seconded by Mr. W. Jolly, the trustees were re-elected. They are Mr. Oliver Stubbs (Past-President), Mr. F. J. Cook (Past-President), and Mr. R. O. Patterson (Past-President).

Diplomas.

The recommendations of the Awards Committee that Major Appleyard (Newcastle), Mr. M. J. Cooper (London), Mr. J. R. Hyde (Sheffield), Mr. J. Longden (Paisley), Mr. W. West (Burnley), and Mr. A. J. Richman (Lancs) should receive the Diploma of the Institute was agreed to.

Vote of Thanks to the Retiring President.

The PRESIDENT proposed a vote of thanks to Mr. Cameron for his services as President of the Institute during the past year. The office of President, he said, entailed a good deal of travelling; inasmuch as Mr. Cameron lived in Glasgow, it would be impossible to choose a President who would have more travelling to do, but, at the same time, the Institute could not have chosen a President who would have done it more willingly. He must have travelled many thousands of miles on the Institute's business, and during the year had visited every Branch of the Institute, with the exception of the East Midlands Branch; also, he had conducted the affairs of the Institute expeditiously, and under the happiest conditions.

The vote of thanks was accorded with acclamation.

New Medal for Past-Presidents.

The PRESIDENT then announced that it had been decided to present to Presidents of the Institute, on the completion of their year of office, a souvenir in the shape of a gold medal, instead of an illuminated address, as had been the practice in the past. It was felt that Past-Presidents would prefer to have a medal. He presented both to Mr. Cameron and to Mr. R. O. Patterson (Mr. Cameron's immediate predecessor) a medal as a memento of their year of office.

MR. CAMERON, responding to the vote of thanks, admitted that whilst it was a relief to hand over the responsibility of office, he did so with a tinge of regret, because he had so much enjoyed the confidence and trust which the members had imposed in him. He had also enjoyed working on behalf of the Institute, and as the result of being privileged to hold the position of President, he felt himself bound more closely than ever to its members and its aims He returned thanks for the medal which had been presented to him.

MR. PATTERSON, who also returned thanks, said that the medal would remain with him through all his life as a very happy memento of his year of office.

Presidential Address.

The PRESIDENT then delivered his address as follows:—

Gentlemen,—I thank you most sincerely for the honour which you have just conferred upon me by electing me your president, but with this sense of appreciation there is mingled a feeling of doubt as to my ability to carry on the work of the Institute in so efficient a manner as my immediate predecessors. In recent years they have been large employers of labour and possessed proved business ability. I regard my election not as a personal one, but perhaps a too-generous recognition of the work of the London Branch during the last few years, and I should have hesitated to assume this office, which becomes more onerous each year, had I not the knowledge of the enthusiastic support of both this branch and the General Council.

Membership Distribution.

In recent years the Institute has taken its place as one of the leading technical organisations of the country; its work is studied and quoted by the world's leading technicians. Its membership not only includes British living in all parts of the world, but Americans, French, Spaniards, Italians, Czecks, Belgians, and the time has arrived seriously to consider whether Germans should not also be admitted, as Science knows no boundaries.

Widening the Scope of the Institute.

A study of the topographical distribution of the membership reveals that the excellent system of organising branches in the various districts containing a fair number of foundries has resulted in a curious situation. Conditions are now such that the Institute is expected to provide a branch wherever two or three foundries exist in one community. The propaganda of the Institute must be so directed and the conduct of its affairs is so arranged that it is definitely advantageous for a foundryman—no matter where he is residing—to associate himself with the Institute. An obvious suggestion is that there should be two meetings annually, one to be in London and to be devoted purely to the reading of technical papers, and the second to be in the provinces or abroad and to take the form now so well established.

Meeting Modern Necessities.

The isolated foundryman, whether at home or abroad, will demand two types of papers—the metallurgical and the practical. About the latter a certain amount of confusion is apparent, traceable to the platitude which enunciates that "what is one man's meat is another man's poison." It is suggested that in the preparation of such papers authors should endeavour (1) to eliminate as many indeterminate expressions, such as "on the hot, soft or dry, side, and the like." The work done in the foundries of the world

MR. H. G. SOMMERFIELD
(*the Honorary Convention Secretary*).

Mr. Sommerfield started his business career as a civil servant, but soon became interested in the exporting of pig-iron. In this he has specialised for many years, and is now a recognised authority on the Scandinavian markets. During the war he was a captain in the Royal Artillery. He has acted as honorary secretary to the London Branch for the last three years.

is of such a diverse character that such expressions do not admit of universal translation and application; (2) to deal with underlying basic principles and to record the successful or unsuccessful making of any particular type of casting as an example of those principles; and (3) to retain as many of his samples as possible, so that if an aspect requires either added metallurgical or engineering work for confirmation, they are available. At the moment, there exists a vast amount of excellent practical theses on foundry topics which demand co-ordination with special reference to underlying principles. At the moment they represent the greatest unedited collection of contradictions the world has ever seen.

Metallurgical and Physical Research.

Foundry industry is urgently requiring a number of constants from which reliable calculations can be made, and there exist two schools of thought as to whose business it is to occupy themselves with this work of a fundamental character. One section insists that this work should be carried out by the British Cast Iron Research Association and another the National Physical Laboratory. Logically, we believe it is more the work

of the latter until such time as the former has enrolled 100 per cent. of iron foundries of Great Britain. Again, if an apparatus has been established for determining the specific heat of cast iron at 1,200 deg. C., it is also probably suitable for similar determinations on non-ferrous metals and would thus be outside the scope of the British Cast Iron Research Association. Thus on the grounds of economy work of this type should be delegated to the National Physical Laboratory, which co-operates with most other research organisations. It should be remembered that being a key industry any progress made by the foundry industry does in varying degrees affect every other industry.

A Key Industry.

During the war Great Britain discovered that its textile industry was basically jeopardised because it was to a large extent dependent on Germany for its dyes. It will be remembered that the Government were considerably perturbed over the situation, and invested the taxpayers' money in a concern formed to create what was designated a key industry. Supposing for a moment that the engineering—civil, mechanical, electrical, agricultural, textile, mining, railway, marine, automobile, constructional, printers, chemical, sanitary and domestic—industries had been dependent on Germany for their castings, then our value as an ally of France would have been about as useful as that of an obscure South American Republic.

Yet to-day, we doubt if the Government or any other representative body recognises the industries the Institute represents as being of "key" character. As a separate entity it does not exist.

Lack of Basic Statistics.

The amount of "raw" materials it uses or imports are unknown, whilst the product of our work is lost in a maze of statistics, only bits appearing as "cast-iron pipes, tubes, etc.," "electrical fittings," "machinery," "agricultural implements," and "other items not specified." Thus is Britain's key of key industries neutral. It is almost entirely unaware of the foreign competition it is expected to meet.

Lack of Buyers' Co-operation.

Furthermore, the industry which should be its best friend—that of general engineering—is often its worst enemy, as it cares but little beyond the unfailing production of a cheap article. There is often less sympathy exhibited between the engineer's buyer and the foundry than between a crooked bookmaker and an impecunious backer.

The correct way for the engineer to assure a constant supply of sound castings is to accord the foundries the fullest co-operation and confidence. The foundries on their part must be in a position to know that the prices they submit are based on reliable costing data, open, if necessary, to inspection and to the technical excellence of product. Of the former the Institute can do nothing beyond the enunciation of underlying principles, but for the latter consideration they willingly admit engineers as members with the object of the mutual consideration of the joint problems.

I consider it essential that those leaders of the engineering industry who possess their own foundries must be taught to realise that they are foundrymen. They exercise some control both as to the wages paid to the industry and the prices received for its product, but judged by their contributions to technical discussions on foundry topics they would benefit considerably by associating themselves much more closely with our industry.

By continued progress the Institute will attract to itself this very important type of hybrid foundryman, who can do so much to promote the industry as a whole. A few of the more enlightened have joined us, and their membership is extremely valuable.

The Modern Foundry.

There is at the moment a distinct field for men who can manage efficiently any type of foundry, whether it makes Diesel engines or rainwater goods. These two extremes have been given because the first requirement for the former is a serious metallurgical knowledge and for the latter a real appreciation of monetary value of the automatic handling of materials. The two are found side by side in a large automobile foundry, which I believe constitutes the best training ground for the potential manager, even though it does lack work of a heavy character. Most foundrymen consider the jobbing shop the ideal school. If a man's object in life is to be an expert moulder there is little room for doubt that it could hardly be improved upon. A knowledge of moulding, however, should not occupy more than 3 per cent. of the thought output of a modern foundry manager. His energy has to be devoted to work of an experimental character and to controlling the efficiency of his staff, the metal, the sands, the face, the machinery, the handling of materials, and the costing system. These, combined with efficient co-operation with the drawing office and pattern shop will diminish to the lowest possible order the control of the moulding, except perhaps in the purely jobbing shop.

Co-ordination by Retrospect.

A well-known pathologist recently stated to me that medical science would benefit if research was prohibited for a few years and an inventory was taken of existing knowledge. I am not at all sure whether this is not equally applicable in the field of metallurgy, excepting, of course, the provision of fundamental data.

The Exhibition.

Though the Institute is precluded from industrial enterprises, its London Branch Council has co-operated with the organisers of the Exhibition in the closest possible way on the technical side. This co-operation has been of the most cordial character, and I believe it has resulted in getting together the finest technical Exhibition of a non-commercial character ever presented to the British Foundry public. Its conception was due to the first president of the Institute, and the strenuous work of its organisation to a very distinguished committee presided over by Mr. Wesley Lambert, who has devoted a great amount of time and energy to its collection and display. I specially ask you all to spend as much time as possible in examining these exhibits.

Finally, gentlemen, I thank you most sincerely for electing me as your president, and I trust that the experiment of having a professional man instead of a business man to preside over your meetings will not prove unsatisfactory.

Vote of Thanks to the President.

MR. J. E. FLETCHER proposed a vote of thanks to the President for his very able address. The members, he said, were delighted to see Mr. Faulkner in the Presidential chair, and they all looked forward to a year of very great usefulness. The Presidential address had raised many interesting points, which would provide much food for thought.

The vote of thanks was carried with acclamation, and the President briefly responded.

Telegram from Czecho-Slovakia.

The PRESIDENT announced the receipt of telegrams from the American Foundrymen's Association, the French Foundrymen's Association, and Professor Pisek (President of the Czecho-Slovak Foundrymen's Association), congratulating him upon his election to the Presidential chair, and expressing the hope that the Institute would have a very prosperous year. The members of the Institute, he said, would be very deeply indebted to these Associations, and he suggested that suitable replies be sent.

This course was agreed to.

The reading and discussion of Papers were then proceeded with, the first Paper read being that of Mr. Arnold Lenz (American Exchange Paper) on "Quantity Production with Quality of Product." It was followed by the French and Belgian Exchange Papers, which are dealt with elsewhere.

Loam Mixture for Pulleys, etc.—The following mixture is suitable for pulleys and similar castings of delicate nature:—Mix together 2 parts of horse manure, 2 parts of old, burnt loam; add to this 4 parts of rock or sea sand and nearly 4 parts of fair loam sand. Wet the whole with a very thin clay wash.

Quality in Quantities.*

By Arnold Lenz, Saginaw Products Company, Saginaw, Mich., U.S.A.

[American Exchange Paper.]

The production of articles in quantities is an outstanding feature of the present industrial era. It is the result of industrial evolution and a product of present civilisation.

The effect of this development in the various industries on the mode of living has been very pronounced. It has raised the standard of living and has given everybody more of the enjoyments of the better things of life by bringing within the means of the masses such things as better clothing, better heating and lighting of homes, improved sanitary equipment, telephones, books, newspapers and even automobiles. Luxuries of a few years ago have become commonplace and will be classed as necessities by the next generation. Quantity production is necessarily confined to the manufacture of commodities, enjoying a wide range of distribution and usefulness, whose application and use are to a certain degree only limited by its cost to the consumer and may vary from a match to an automobile.

This method of manufacturing has invaded every industrial field and has been equally successful in high and low quality articles. Although there is evidence of this on every hand, there are still a large number of manufacturers as well as consumers who refuse to recognise this truth. They persist in associating quantity production with cheapness, not only in price, but in quality also. This is erroneous and can only be attributed to a misconception or ignorance of the fundamentals of quantity production.

Since the price and the usefulness of a commodity are the controlling factors in its distribution, the quality is, as a rule, predetermined and fixed in advance. Production has therefore to adjust itself to quality and not quality to production. This is well illustrated in the textile industry, one of the first industries to adopt quantity production. Here the efforts to produce goods in wool, cotton, linen and silk of a quality and price to satisfy the needs of people of humble circumstances, has not prevented that industry from producing, sometimes in the same institution, textiles of the finest quality that will satisfy even the most exacting taste. The automobile industry is another example. There are cars of a great variety in quality and price, and the few manufacturers who do not build on a quantity production basis are prevented from doing so, because their prices are restricting their market to a point where the application of quantity production is no longer practical or possible.

Quantity Production as Applied to the Foundry Industry

There has been considerable criticism that the foundry industry has failed to keep pace with the general industrial development. While this criticism is not wholly unfounded, it has, in most cases, been offered by people who have little or no knowledge of the peculiarities and difficulties incident to the foundry industry and has, as a rule, been devoid of the practical and helpful suggestions which every progressive foundryman is eagerly seeking.

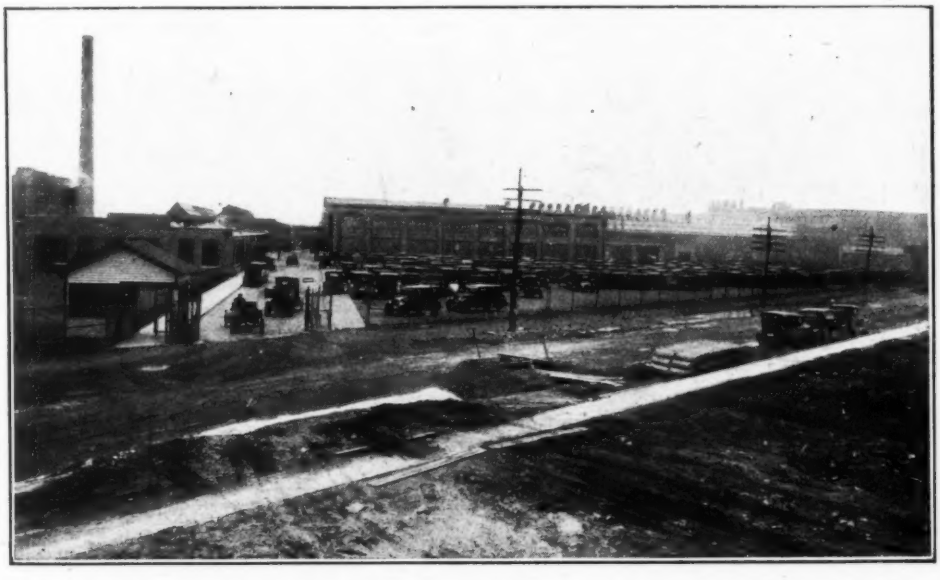


FIG. 1.—ONE OF THE QUANTITY PRODUCTION FOUNDRIES OF THE SAGINAW PRODUCTS COMPANY. HALF THE CARS SHOWN ARE THOSE BELONGING TO THE WORKMEN.

This is an age of specialization and it is leaving its mark on the foundry industry. Specialization has already removed from the jobbing foundry such castings as fittings, pipes, radiators, railway car wheels, sanitary equipment, bearings, bushings, automobile castings, etc., and there are many more to follow. Once a casting has entered the specialty field, price and uniformity of quality place it beyond the reach of the foundry producing a general run of castings.

The limited number of any one piece and the nature of the castings produced by the ordinary jobbing foundry makes the application or adoption of even some of the well established foundry devices and equipment impractical. It is only the specialty or production foundry that can take full advantage of all the modern mechanical, metallurgical and chemical developments and it is to these foundries that the foundry industry owes its rapid development of the past few years. In the manufacturing of castings, as in any other commodity, quantity is the only limiting factor in the application of production methods. Quality and intricacies of design are only influencing factors as far as the selection of the equipment and method of manufacturing is concerned.

Judged from a standpoint of quality and intricacy of design, the automobile industry requires perhaps the highest grade of castings.

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* A Paper read yesterday before the Annual Conference of Institute of British Foundrymen.

That these castings cannot only be successfully produced, but that also a higher grade of quality is possible under quantity production methods, is a well-established fact.

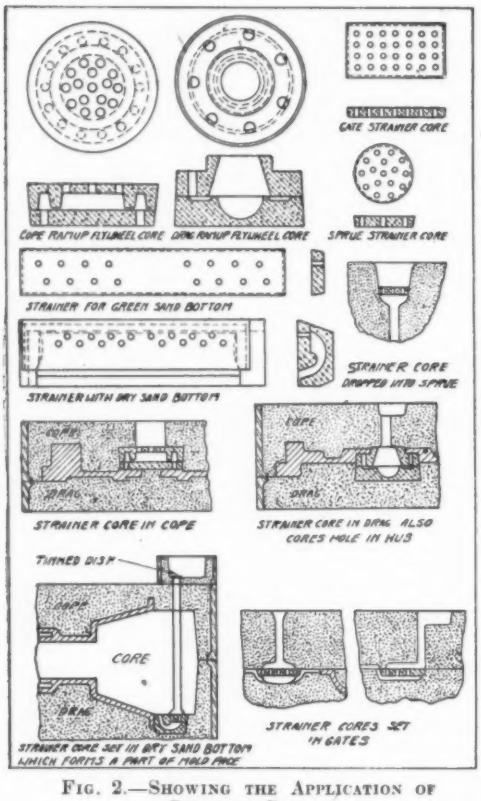
GATE STRAINER CORE
COPE FLATUP FLYWHEEL CORE
DRAG FLATUP FLYWHEEL CORE
SPRUE STRAINER CORE
STRAINER FOR GREEN SAND BOTTOM
STRAINER CORE DROPPED INTO SPRUE
STRAINER WITH DRY SAND BOTTOM
COPE
DRAG
STRAINER CORE IN COPE
STRAINER CORE IN DRAG ALSO CORES HOLE IN HUB
TURNED DISH
CORE
STRAINER CORES SET IN GATES
STRAINER CORE SET IN DRY SAND BOTTOM WHICH FORMS A PART OF MOLD PROP

FIG. 2.—SHOWING THE APPLICATION OF STRAINER CORES.

some of its main features will be set forth in the ensuing paragraphs.

A foundry producing automobile castings as a specialty differs from the specialty foundry producing radiators, car-wheels, pipes, etc., in that its general layout and equipment must have greater flexibility. With the exception of one or two well-known makes, there has been a constant changing in designs of motor-cars which, while perhaps not so apparent to the public, causes a seasonal readjusting and reorganising of the methods employed in the production of the necessary castings. In selecting core machines, moulding machines, conveyors or cleaning room equipment, this factor must be taken into consideration and a reasonable allowance must be made to take care of the changes of size, shape and weight of the various castings.

Labour and Management.

One of the outstanding features of a quantity production foundry as compared with the regular type of foundries lies in its working force. Instead of the trained and seasoned artisans which one would associate with the production of intricate castings of high quality, the staff is composed entirely of specialists, trained only in their respective operations which are reduced to the smallest unit and the simplest form possible. This, however, does not mean that such a force is a conglomeration of nondescript labour; on the contrary, some of these people become highly skilled and are able to perform their operation very accurately and with what is to the uninitiated, incredible speed. Their performance compares well with the speed of an all-round athlete.

A production foundry, employing about 2,500 men, may not employ over 10 full-fledged moulders and coremakers. The burden of supplying the necessary knowledge of the details involved in the manufacturing of a great tonnage of intricate castings falls, therefore, entirely on the management. For this reason, the successful operation of a production foundry, of this nature, depends largely on the ability of the

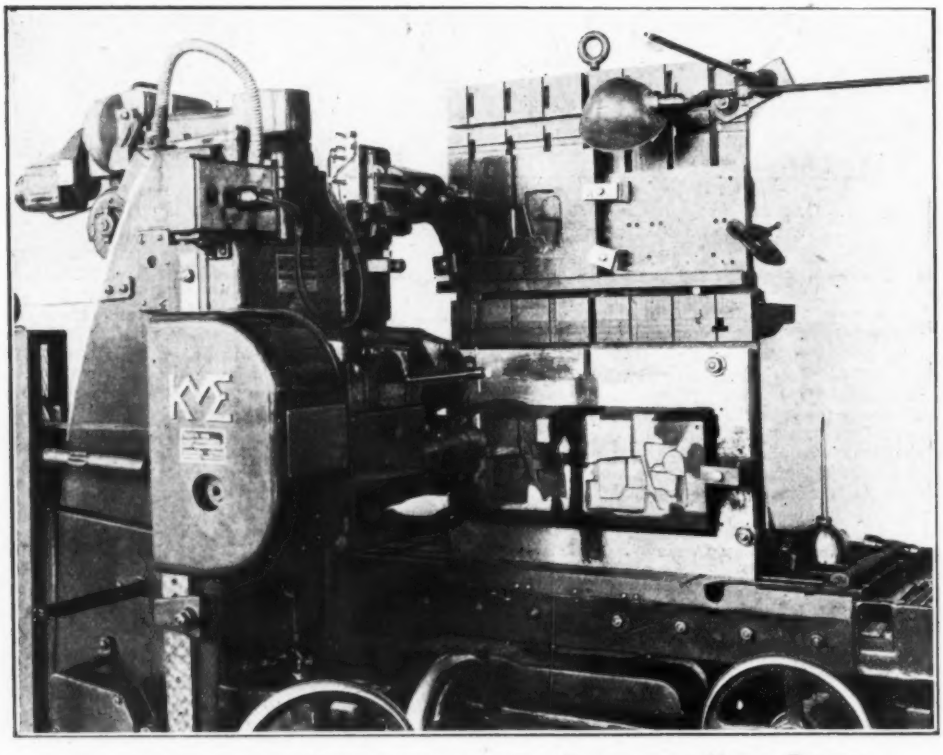

FIG. 3.—A PROFILING MACHINE PRODUCING CORE BOXES FROM A MASTER PATTERN.

Since, in addition to its own peculiarities, the automobile-casting foundry has also many of the problems and conforms in a general way to the production of other castings on a quantity basis, management to choose the most effective methods, to standardise the various operations, to select the most efficient equipment and to maintain it, to design the necessary special appliances and to

organise its force in such a way that the product will flow through the plant in a continuous uninterrupted manner. This is best accomplished if the executives are advanced from the ranks by merited promotion.

Although the chief aim of quantity production is toward lower costs, its introduction has, in some instances, been actuated by a shortage of all-round mechanics. Contrary to what certain short-sighted labour leaders would have one to believe, quantity production was never designed to lower the wages of the working man, nor was it designed to exclude trained artisans from these plants. The absence of union moulders and core makers is entirely voluntary on their part and must be charged to their reluctance to do repetition work and the restrictions of the unions as applied to production.

Piece Work as Wage Incentive.

A prevailing mode of wage payment is piece-worked based on time studies. A day's work constitutes what a man can do without injury to himself over a long period of time. It is based on an average man and does not represent the maximum of the exceptional worker. The time required by a new man to reach the specified rate of production may vary from one to two days on some minor operations, to one to three weeks on the more skilled. In the foundry, the rammers are usually recruited from the labourers and the finishers and core-setters from the rammers.

The beginner is usually guaranteed a certain day's wage which varies somewhat with the operation, but does in no case fall below the prevailing labour rate. The base rates, which are the amounts the men are to receive for 100 per cent. production, compare with the prevailing common labour rate approximately as follows:—

	Per Cent.
Moulders	180 to 200
Core makers and core assemblers (male)	150 to 175
Core makers (female)	150 to 200
Iron pourers	150 to 160
Shaking out of moulds (hot) ...	150 to 160
Melting	150 to 160
Cleaning department	125 to 150
Sand blasting	200 to 210

To what extent the workers prosper under this system can be judged, in a measure, from the photograph of the front yard (Fig. 1) of one of the production foundries with which the author is identified, which shows about 50 per cent. of the automobiles belonging to the workmen.

Materials.

The proper selection and control of raw materials are important factors in the production of quality castings, and the repetition of standardised operations presents an opportunity for checking and noting the effect of the various materials on the quality of the product, far beyond that possible by ordinary foundry methods. Therefore, a fully-equipped laboratory, in which the various materials and products are tested and analysed, forms an indispensable part of the production foundry.

While materials such as coke, iron, sand, limestone, corebinder, etc., are all closely checked in the laboratory, the effect of the physical structure and source are recognised as important factors. This is especially true with coke and iron as applied to castings calling for a high Brinell number, density, and high-speed machining qualities. Two brands of coke of practically the same analysis but differing in structure may produce iron with a difference in Brinell hardness of 25 to 30 points. The same is true of the combination of different brands of iron.

Special attention must be given to the variation between pigs in one truckload. Apart from an average analysis, the specifications should also call for a limit in variation. These specifications can usually be met at the blast-furnace by confining the iron loaded into any one truck to one tap, which is facilitated by the steady flow of deliveries required in a large foundry.

While a limit in variation is important in cupola practice, it is not so necessary where iron is melted and held in large quantities, as in an open hearth or in an air furnace, because it is much easier to maintain an average.

The large consumption and the adherence to a standard practice, not only in methods, but in materials also, enables the producers of pig-iron, coke, sand, corebinder, etc., to furnish these materials to very close specifications and the desirability of this business usually brings forth the fullest co-operation in scheduling and guaran-

FIG. 5.—GRAVITY CONVEYORS FOR CONTINUOUS POURING FOR THE REDUCTION IN QUANTITY OF BOX EQUIPMENT.

teeing deliveries. This is especially true where the producers have the assurance of continued business relations which, however, does not necessarily mean long-time contracts.

Core sands are usually used in the natural state, but there is a growing tendency to have all moulding sands milled and blended to a specified bond at the pits, which eliminates the uneven and lumpy condition usually found in highly-bonded sands.

Among the corebinders, the greatest variation is found in core oils, which still constitute the chief binding material for intricate cores. While linseed oil is still considered the standard, some of the prepared oils are more economical, and because the tendency to gum-up the coreboxes is greatly reduced they lend themselves better to high-speed production. Core oil should only be bought from the most reliable sources, and great stress should be laid on uniformity, which is much easier obtained by buying in tank-car lots than in barrels. A quick and quite satisfactory way of testing incoming oil before unloading is to mix two small batches of silica sand, one with the new oil and one with a standard oil, such as pure linseed (kept in the laboratory for this purpose). A definite quantity of each is rammed into briquettes, placed on the same plate, dried at the customary temperature and tested for relative, rather than a given, strength. If, in addition to this, the colour of the oil matches a predetermined sample, it is quite safe to put into production. The iodine value, etc., can be checked later.

For best results, an oil that will withstand a fairly-high baking-temperature should be selected, and if the cores are inspected for defects before going into the ovens, even intricate cores requiring much handling in cleaning, grinding and assembling can be produced with a 3 to 4 per cent. loss.

Meeting New Demands.

The demand of the consumers for better quality, greater uniformity and closer dimensions is increasing with every year. The amount of metal to be taken off on finished surfaces by the machine shop is being constantly reduced until it is not uncommon to have an allowance of only 1/32 in. on even a good-sized casting.

Only a few years ago it was thought impossible to shake out thin-walled castings, such as cylinder blocks, before they had almost completely cooled. Any castings that were taken out of the sand whilst red hot were sure to develop a heat crack or a

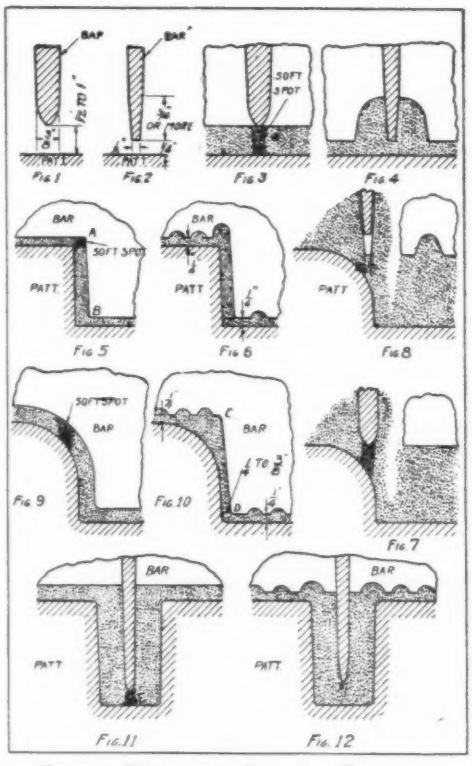

FIG. 4.—PROPER AND IMPROPER DESIGN OF FLASK BAR FOR JOLT MACHINE RAMMING.

Sketch 1 and 2.—Contrast of properly designed bar of Fig. 2 for machine ramming with common type of design, which does not give good results, as soft spot is usually left under bar, as shown in Sketch 3.

Sketch 4 shows proper design of bars at joining of two cross bars.

Sketch 5 and 6.—Sketch 6 proper design of bar in contrast with improper design of 5.

Sketch 7 and 8.—Sketch 8 shows proper design and spacing of bar contrasted with improper design of Sketch 7.

Sketch 9 and 10.—Sketch 10 shows proper design of bar contrasted with improper design of Sketch 9.

Sketch 11 and 12.—Sketch 12 shows proper design of bar for lifting sand from groove pocket contrasted with improper design shown in Sketch 11.

FIG. 6.—A POWER CONVEYOR UNIT FOR PRODUCING 2,100 CYLINDER CASTINGS IN NINE HOURS.

warp, and special precautions were always taken to avoid any premature shaking out. With continuous pouring and the necessity of conserving floor space came also the development of iron that will withstand sudden changes in temperature without ill-effects, and the shaking out of castings while red hot is becoming the rule rather than the exception. Incidentally, this solution has also produced a superior product by greatly reducing the danger of cracking in service.

Various expedients, such as hollow cores, etc., have been resorted to in the past to produce a uniform hardness throughout the full length of the bore, because the slow cooling condition in the region of the water jacket and the valve seats produced a softer iron. This soft section was usually located where the piston rings caused the most wear, and if the iron was made hard enough to counteract this condition, the flanges and thin sections were usually so hard that they could not be machined, even at ordinary speed. To-day, with only slight changes in the analysis, cylinder blocks can be produced with a uniform hardness in the bore, in which the thin sections can be machined at high speed.

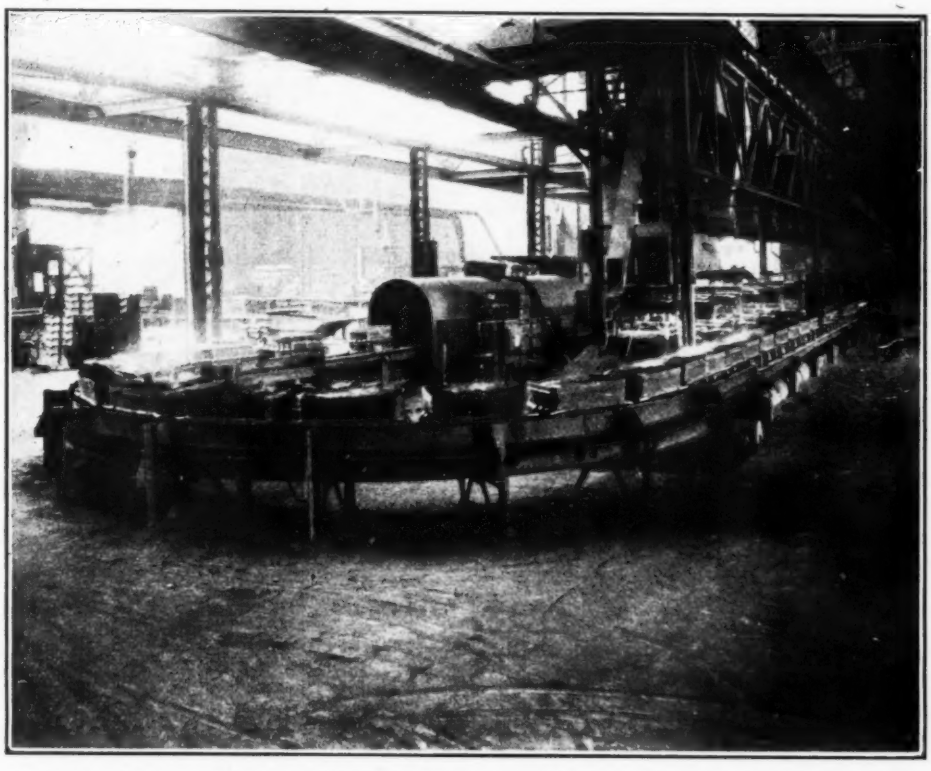

FIG. 7.—A POWER CONVEYOR UNIT FOR PRODUCING 2,300 CYLINDER HEADS IN NINE HOURS.

Another vexing problem that confronted the foundryman in the development of quantity production was the placing of risers on castings for the purpose of feeding, either by gravity or churning, and this problem has been solved to a point where risers for any purpose can be eliminated on automobile castings. The greatest difficulties in this direction were presented by flywheels, which usually have a thin web and a heavy rim. Some foundrymen have met this situation by arranging the poring basin so that it will also act as a feeder, but even this is not necessary if a properly designed strainer gate is used.

At one time it was thought impractical to let anyone but experienced moulders pour the iron, but with the advent of continuous pouring it was soon apparent that the efficiency of the moulders could be greatly increased by relieving them of this arduous task. Pouring crews which did nothing but pour iron were therefore formed. At first it was attempted to teach them to judge the proper pouring temperatures of the various castings and impress upon them the importance of skimming the iron; but during the hot summer months, when the labour turnover necessitates the constant use of new men, it was soon found that their knowledge had to be reduced to the simple operation of keeping the pouring basin, or sprue, filled to the top. This situation was met by placing tin discs over the sprue, and the application of strainer gates which skim the iron and regulate the pouring temperature. While they have not been generally adopted, they have definitely proved their value and usefulness in the making of automobile castings, because iron will more readily rid itself of slag and produce a more uniform quality if it is melted and poured at a high temperature. If convenient, the iron may be strained through openings placed in the regular cores, but ordinarily it is easier to make separate strainers for this purpose, and Fig. 2 shows a number of such cores and their application.

(To be continued.)

Sir W. G. Armstrong, Whitworth & Company, Limited. — At the 32nd annual meeting of Sir W. G. Armstrong, Whitworth & Company, Limited, held at Newcastle recently, LORD SOUTHBOROUGH presided, and announced that within the last few days he had been elected chairman. When Sir Glynn West, deeply sensible of the embarrassments which in these bad times had overtaken the company, decided to resign, four other directors (Mr. J. M. Falkner, Sir G. H. Murray, Sir C. L. Ottley, and Lord Sydenham) took the same course, in order to give the remainder, under the advice of their financial advisers, an opportunity of reconstituting the board and fitting it for the anxious work which lay before them. The services of Sir Glynn West would be at their disposal in the investigations which were proceeding with the determined object of straightening out the affairs of their famous company. They had a new colleague in Mr. Frater Taylor and Sir A. Kaye Butterworth, late general manager of the North-Eastern Railway, had agreed to accept a seat on the board. As the reforms already initiated advanced they would invite other men well qualified to assist them in their labours. Lord Southborough reviewed the history of the company during three outstanding periods—pre-war, during the war, and after the war—remarking that at the moment it was impossible to speak with any degree of certainty as to the immediate future. Certain of their after-war efforts had necessitated heavy investments, which from the financial point of view had been unsatisfactory. That particularly applied to their investments in the Newfoundland Power & Paper Company.

Non-Ferrous Metallography.*

By J. S. Glen Primrose, A.R.T.C., A.I.M.M. (Assoc. Member), Manchester.

(*Continued from page* 456.)

Referring to a series of zinc-base alloys, quite remarkable types of structure can be revealed in these by proper etching. The simplest is the well-known cubic or rhombohedric formation when a definite compound is formed and has but little solubility in the matrix. The size of the separated particles reflects accurately the rate of cooling attained by the mass, and Fig. 7 shows how, in the case of hard spelter in accretionary form, it can quite suddenly change the size of the crystal grains separated. The average analysis of this dross showed 3.5 per cent. of iron (which was practically all united with the zinc, forming the higher melting-point crystals which were the first to separate as the mass cooled), and 1.5 per cent. of lead, not visible in the zinc-rich matrix etched black in the photo-micrograph taken at 50 diameters.

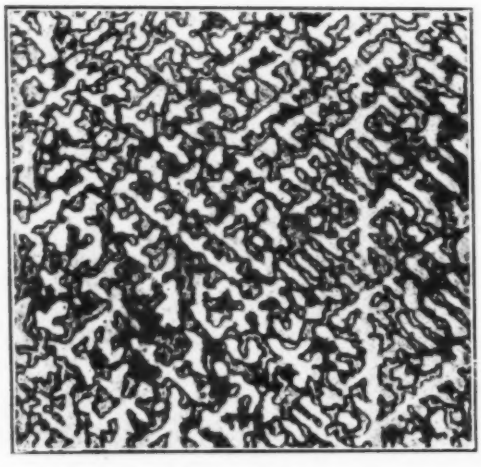

FIG. 15.—WELL-CAST PHOSPHOR-BRONZE (V—50—X).

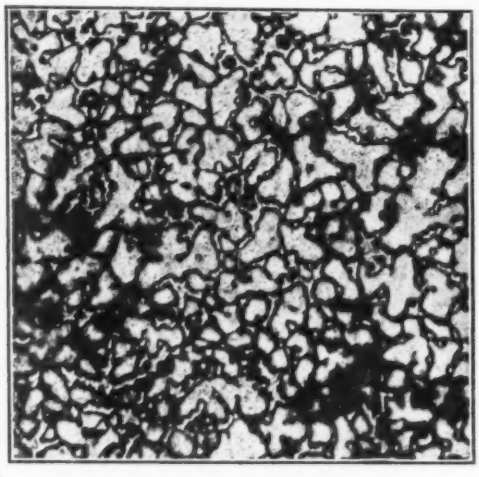

FIG. 16.—PHOSPHOR-BRONZE CAST AT TOO LOW A TEMPERATURE (V—50—X).

The "onion" type of freezing suggested by Professor Howe[5] is an almost ideal form of structure for certain purposes, but it is very rarely met with in practical experience, about the only example known to the writer in his small amount of non-ferrous metallography work being the Prana alloy No. 4, shown in Fig. 8 at 50 diameters magnification. In this view, the alternate layers of light and dark etching constituents are distinctly arranged in concentric formation, except where two or more crystallisation centres mutually interfere, and produce a double right-angled appearance shown at the bottom of the figure.

FIG. 17.—BRITTLE PHOSPHOR-BRONZE (V—50—X).

Needle-shaped spines and conglomerates of these into stars are common non-ferrous alloy formations, and these show up the more clearly when the matrix containing them is eutectiferous, and thus of much lower melting point. Thus Figs. 9 and 10 show two zinc-base alloys to which both aluminium and copper have been added in the following percentages, in the endeavour to secure a suitable fuze metal to meet the specification called for and detailed below:—

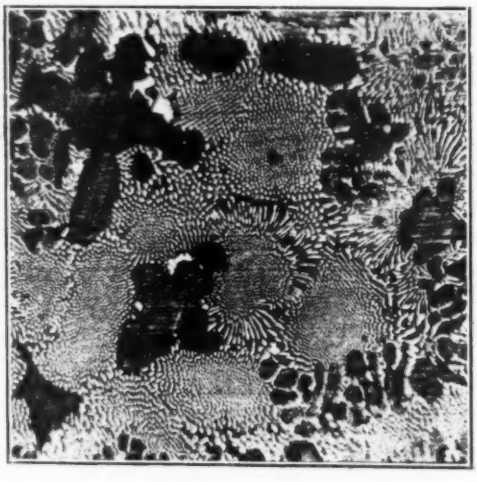

FIG. 18.—"SWEAT" FROM PHOSPHOR-BRONZE (V—50—X).

Fuze Metal.	Zn	Cu	Al	Pb	Tensile.	Compression.		Hardness.
						El. Lt.	Ul.	
					Tons.	Tons.	Tons.	
Fig. 9	92	2	6	tr.	6	21	56	105
Fig. 10	90	5	4	1	15	33	58	—

The specification called for a compression breaking load of not less than 60 tons per sq. in., whereas the above did not quite come up to this. The elastic limit in compression, well over 20 tons for both above samples, was not definitely called

* A Paper read before the Annual Conference of Institute of British Foundrymen.

for, but after a load of 8 tons per sq. in had been applied, the cylindrical test piece must not show a reduction in length of more than 1 per cent. As a measure of ductility and ability to forge, the specimen should not show any signs of cracking after it had undergone a 35 per cent. reduction of length. In making the tensile test, the ductility, as measured either by percentage elongation or reduction of area, was not deemed sufficient, being only 1 per cent. in each case. The alloy containing lead was still less ductile, and only recorded 0.5 per cent. elongation on the standard 2-in. gauge length. Although these alloys were understood to be forgeable at 250 deg. C., it was generally found

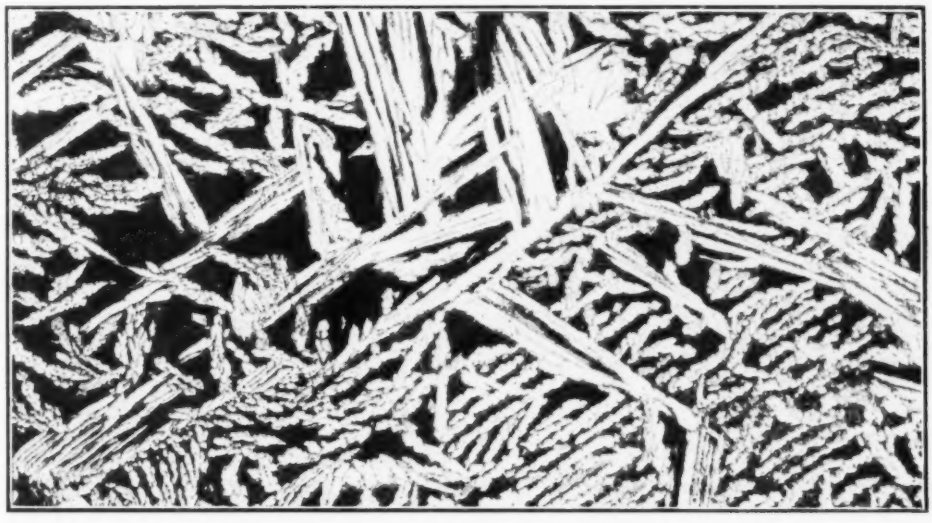

FIG. 19.—ALUMINIUM-NICKEL-BRONZE AT 50 DIAS.

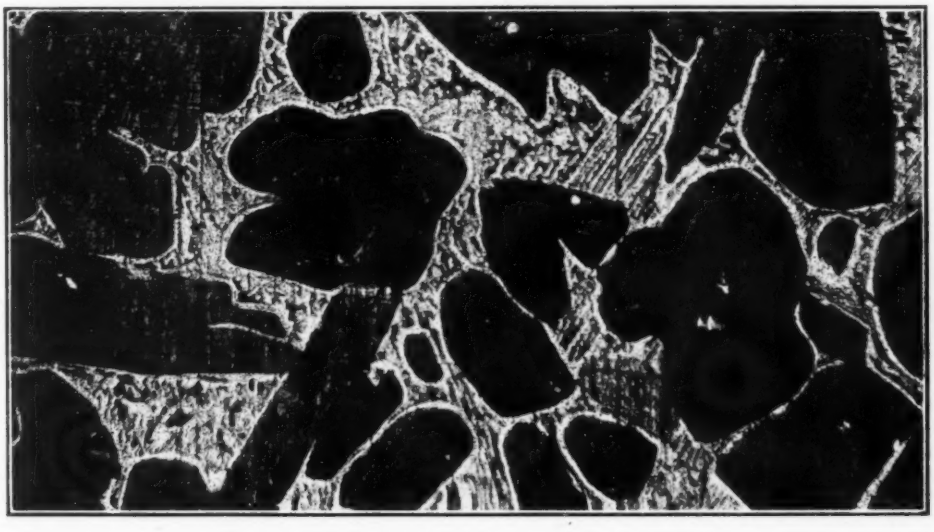

FIG. 20.—ALUMINIUM-NICKEL-BRONZE AT 200 DIAS.

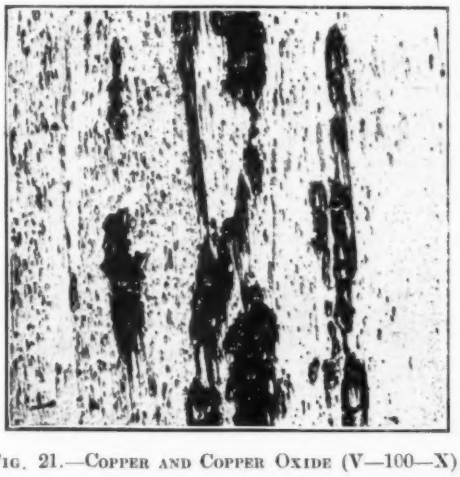

FIG. 21.—COPPER AND COPPER OXIDE (V—100—X).

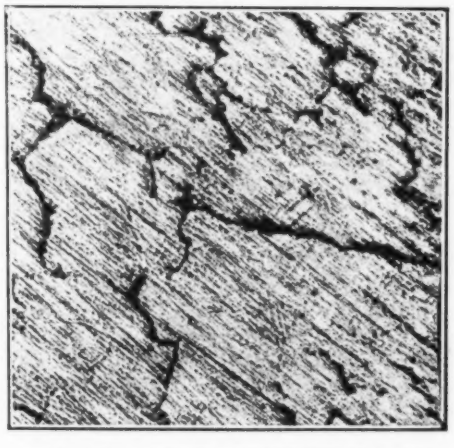

FIG. 22.—GASEOUS INTERGRANULAR PENETRATION RENDER COPPER ALLOYS BRITTLE (V—200—X).

advisable to take them up to about 400 deg. C., but it was necessary to heat them up slowly, first to about the 250 deg. C. in an oil bath, and then for a few minutes at the front of a gas furnace, before being stamped in the screw press, to get the rough forging suitable for subsequent machining.

Brasses.

The foregoing zinc-base alloys were never able to replace successfully the forging brasses for the purposes of fuze metal, and four micrographs (Figs. 11 to 14) at 50 magnifications clearly show the differences between the grades of alpha-brass

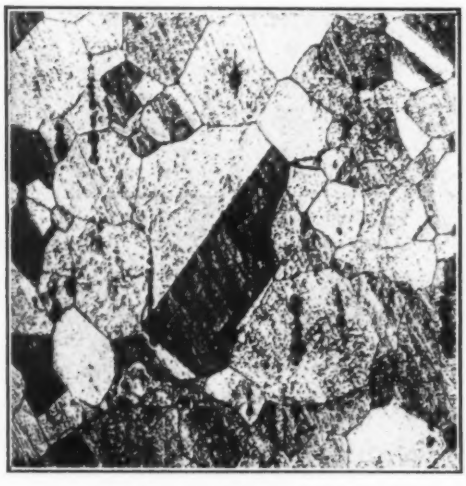

FIG. 23.—NORMAL ANNEALED STRUCTURE OF HIGH MAGNETIC PERMEABILITY FERRO-NICKEL (V—400—X).

and the several grades of alpha-beta brass around the 60:40 composition, all of which were forgeable but which possessed different degrees of machinability. Table I serves to compare the specified strengths of the several classes with the actually attained physical characteristics corresponding to the four different structures shown:—

forging or press-stamping operation in the hot state imparted an elongated form to the constituents, similar to that often observed in extruded metal.

Bronzes.

In the tin- and phosphor-bronzes which are most commonly used for bearing metals, one of the most important matters is to ensure, apart from their soundness and freedom from blow-holes, the proper structural arrangement of the primary copper-rich crystallites, which should form the interlocking type of arrangement, and have the inter-special delta material in small, uniformly distributed, and, if possible, isolated patches. Figs. 15, 16 and 17 show, with the accompanying physical tests (Table II), the effect of attaining or losing this desired structure.

The structure shown in Fig. 15 is that of a well-cast metal, the temperature having been suitable for the size of article involved. By contrast, the metal shown in Fig. 16 has evidently been cast at too low a temperature, and resulted in the suppression of the dendritic growth of the primary crystals, whilst the eutectoid has formed an almost continuous network in spite of the lower tin-content than No. 15. In addition to being deficient in strength, this bearing would not stand up to such prolonged wear as the first. An exceedingly brittle arrangement of the constituents is the rectangular one shown in Fig. 17, which metal was not chill-cast, as it might appear to have been. Such a bearing metal might stand up fairly well if put into service where no serious shocks were likely to be encountered, but even then the large amount of delta-eutectoid present would be apt to promote scoring of anything less than a hardened journal.

When large percentages of tin are present, either alone or along with some residual phosphorus, there is a great tendency for some of this delta-eutectoid to exude or ooze out of the casting, particularly from the riser and runners, as the metal cools and contracts. The erroneous idea that this "white" metal is purely tin is not only clearly proved by analysis, but also, when the particles are too small for this, by the micro-structure they show. Fig. 18 indicates the complex nature of this "sweat," since, in addition to the ternary eutectic of copper-tin-phosphorus, there are quite an appreciable number of the

TABLE I.—*Correlating Mechanical Properties of Specified Brasses with the Micro-structure.*

Fuze Metal.		Class.	E.L. Tons/sq. in.	T.S. Tons/sq. in.	E. per cent.	R.A. per cent.	Brinell hardness.
Alpha brass	(Specif.) ..	A	20	30	20	—	—
	(Fig. 11) ..	A	20.4	40.2	23.5	23.1	170
Alpha-beta brass	(Specif.) ..	B	12	20	30	—	—
	(Fig. 12) ..	B	13.2	30.8	32.1	27.2	110
Alpha-beta brass	(Specif.) ..	C	6	12	10	—	—
	(Fig. 13) ..	C	10.8	29.2	16.8	19.0	120
Alpha-beta brass	(Specif.) ..	G	8	20	20	—	—
	(Fig. 14) ..	G	9.4	23.2	29.0	32.9	105
In compression	(Fig. 11) ..	A	22.2	62.7	13	on 1in. at fracture; and only 10 per cent. reduction in length after the application of 40 tons per sq. in.	

TABLE II.—*Correlating the Chemical and Mechanical Properties of Bronze with the Micro-structure.*

Fig. No.	Analysis of bronze.			Physical tests.				Brinell hardness.
	Copper.	Tin.	Phos.	E.L. Tons/sq. in.	T.S. Tons/sq. in.	E. per cent.	R.A. per cent.	
15	86.6	12.2	0.06	10.0	15.2	5.3	4.9	90
16	85.6	11.2	0.29	3.0	10.0	1.8	1.2	70
17	85.0	14.3	0.18	2.5	6.0	2.0	1.0	105

In the case of detent parts, the necessary physical properties could rarely be attained in the plain casting, and the necessary forging, after heat treatment, was needed to reach the high values shown under class "A." Both "B" and "C" could best meet the requirements if the metal were carefully melted, without stewing, before being cast into chill moulds. With moderate care the requirements of "C" could be met without this precaution, but as common scrap materials were often utilised in its manufacture, sufficient care was not often expended in keeping the melt free from dross. The "G" metal used for the forging proper was usually best cast in a chill mould, and in many cases the subsequent dark-etching copper-rich dendrites present. Naturally, such pellets are exceedingly brittle, and indicate the extent to which segregation can occur within drawn places inside the casting.

Aluminium Alloys.

So many of these have now been utilised in the foundry and fully described recently that it is not necessary to recapitulate those of the low specific gravity end of the diagram. There are still many avenues of the copper-aluminium alloys to be explored, and a very interesting case of the remarkable property some of these have of self-annealing themselves in the process of casting came to the writer's notice. A very heavy-duty

bevel-wheel of over 3 cwts. had been tried in several alloys, until a mixture was finally recommended and tried which contained copper, 83; aluminium, 10; nickel, 6; and zinc, 1 per cent. A separately-cast test-bar was found to be similar in strength and structure to the risers of comparatively small section. It was not, however, until the machine was being scrapped in which the actual wheel was used that portions of it were examined for structure, and the comparison is shown in Figs. 19 and 20. In the former at 50 diameters the structure is of the simple alpha-beta type, due to the comparatively rapid cooling. The larger mass, which had cooled more slowly, showed the complete change possible in this type of structure due to self-annealing, whereby the beta

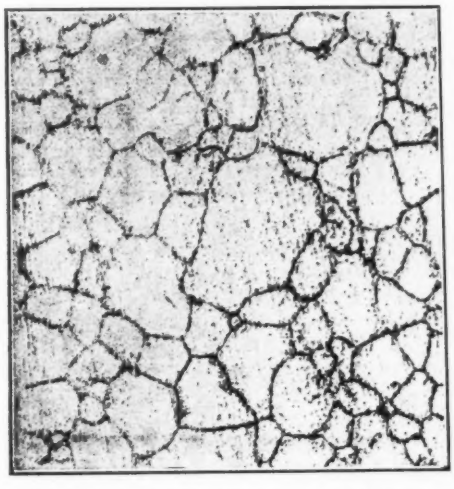

FIG. 24.—SHOWING INFLUENCE OF GASSING THE ALLOY SHOWN IN FIG. 23 (V—400—X).

constituent can break down into either a gamma or delta eutectoid which forms the interspacial matrix around the primary crystals rich in copper, and in this case containing most of the nickel in solid solution. The minute nature of the particles in the eutectoid will be realised from the greater magnification of 200 diameters required to resolve it in the photo-micrograph, Fig. 20.

Copper.

Apart from the harmful amount of oxygen sometimes taken up by copper when remelted from ingot form, there has recently been a crop of obscure troubles in refined copper, chiefly of American origin, which has been put down to "gassy" copper. A considerable amount of research work has been expended upon this matter, and the result points to two causes; one of which is an excessive amount of oxygen present in the form of cuprous oxide, and the second cause to copper with a more moderate amount of oxygen which very readily became brittle on being heated in a reducing atmosphere. When copper is being refined, or even when electrolytic copper is being melted to cast it, cuprous oxide forms rapidly, and is soluble to a slight extent in the molten copper. It should be almost completely removed by the poling operation, and only sufficient left to control the "setting" of the open-mould cast-bars to produce the required level surface in the common "crimped" form. If too long a time elapses during casting and before poling is again resorted to, there is a danger of an excessive amount of oxygen being taken up, and this commonly shows itself in a layer near the top skin of the ingot or bar, and in certain cases it even exudes as small pimples on the ingot surface. The analysis of such metal may be all that is desired, apparently, as it is somewhat difficult to estimate oxygen content, especially when so completely segregated, but the microscope reveals the harmful effect very clearly. Thus Fig. 21 at 100 magnifications shows not only the easily-recognised eutectic structure of copper with cuprous oxide in the copper ground-mass, but also considerable masses of free oxide in slightly globularised strings occurring near the surface even after the copper has been reduced in size, and any possible excess-scale given every opportunity of being removed. The only cure for this fault is better casting conditions and care in obtaining the correct casting temperature.

The other trouble caused by gassing in a reducing atmosphere has long been known as the effect of reducing the copper oxide, which occurs in less highly-enriched copper as pearlitic patches of eutectic at the grain boundaries. This produces spongy material around the grains of copper and causes pronounced brittleness, as the fracture always occurs between the crystal grains. A very useful form of heat-treatment has recently been devised to overcome this possibility of brittleness, the explanation for which is clearly shown in the photo-micrograph, Fig. 22, revealing the intergranular nature of the gaseous penetration. It has been found[1] that by a proper annealing, followed by slow cooling, the cuprous oxide meshwork can be spherodised just like pearlite, and balled up into tiny patches located throughout the copper matrix, without being in the grain boundaries. The gassing or heating in any reducing atmosphere no longer had any harmful effect upon the ductility of the metal, because where the cuprous oxide had been there only remained tiny holes in the metal lined with spongy copper. Since these blow-holes were scattered through the metal in disorder, no brittle grain boundaries were found to exist, and the trouble was eliminated.

Nickel Alloys.

The extent to which nickel and its alloys can be rendered non-malleable by oxygen is only slight compared with the astonishing effect which

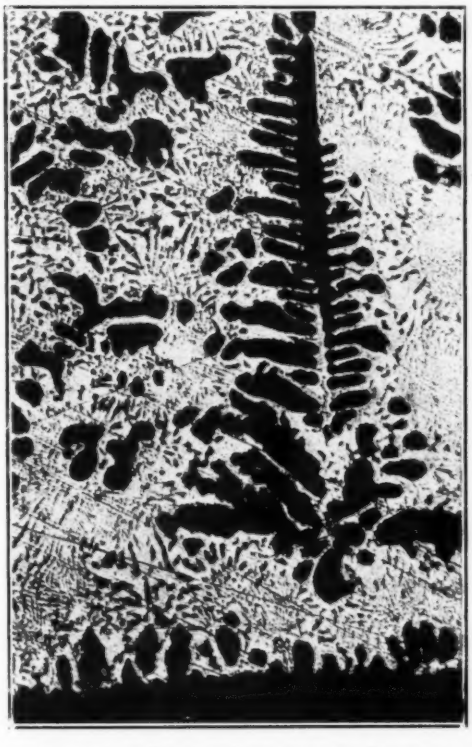

FIG. 25.—SILVER SOLDER—THE NORMAL STRUCTURE (V—500—X).

sulphur has in this respect. The former idea that the addition of magnesium had the effect of removing the oxygen has now been dispelled, and the true case for the expulsion of the sulphur by magnesium has been demonstrated.[2] A remarkable similarity has recently been found in the working of some of the nickel alloys with that of copper, in regard to its ready embrittlement when being annealed, a structure exactly resembling that of "gassed" copper resulting. One of the new alloys of ferro-nickel renowned for high magnetic-permeability, shown in Fig. 23, illustrates the normal structure of tough and ductile metal when it has been properly annealed. Whenever the

temperature is sufficiently high, and gassing conditions prevail, then the surface is converted into a mass in which the grain boundaries are embrittled, and differ considerably from the normal metal. Such a state of affairs is shown in Fig. 24, which deleterious effect can only be removed by strong chemical or mechanical means when the unattacked portion retains its customary properties.

Silver Alloys.

One of the most useful applications of this semi-precious metal to engineering purposes is in the preparation of the so-called silver solder, which consists of a brazing metal to which a varying proportion of silver has been added. This series of alloys give rise to some of the most interesting forms of eutectic structure, which is capable of numerous modifications. In the usual variety for high conductivity work, the percentage of silver added is usually 8 per cent., and when used in conjunction with copper the initial copper-rich crystallites to form are generally well-marked and contiguous to the joined surfaces. Further in,

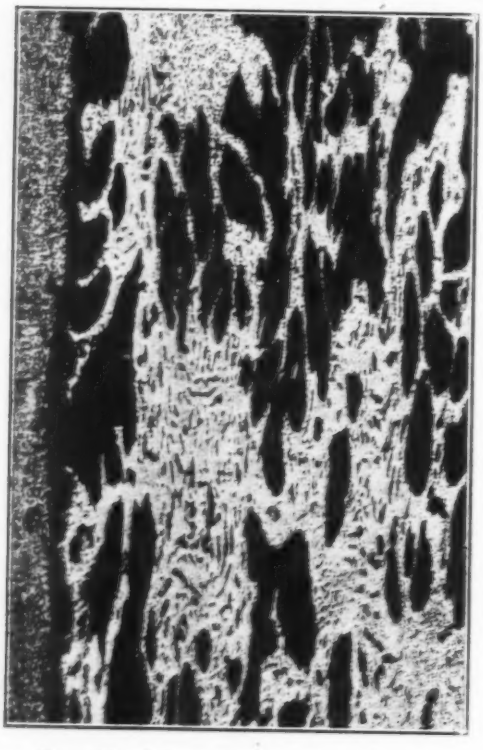

FIG. 26.—SILVER SOLDER IN A BRAZED JOINT (V—500—X).

as shown in Fig. 25, the tree-like forms of these crystallites have free scope to develop in the silver-zinc eutectic, which can form beautiful patterns, most of which are highly-ductile for such a material. Thus when the cross-sectional area of the braze has been considerably reduced, the deformation figures of the copper-rich crystallites and the surrounding eutectic are often grotesque, but indicative of strength and non-liability to parting company, as seen clearly in Fig. 26, which, like the former photo-micrograph, has been taken at 500 diameters magnification, and shows the copper base with the solder attached.

Conclusion.

The enumeration of cases in which the microscope can prove of inestimable value to the non-ferrous metal worker is almost endless, but it is hoped that the present selection of instances and illustrations will serve to assist those who have not yet seriously contemplated the installation and continuous application to practical purposes of a reasonably good microscope, and wherever possible a serviceable photographic outfit, in making a step in that direction, since the knowledge gained in this way cannot be equalled by that obtained in any other direction, and is most fruitful in attaining better results when applied in common-sense manner.

The writer desires to express his indebtedness to Mr. H. S. Primrose, M.I.M., for assistance in connection with the analyses quoted, and also to the numerous firms whose products have been investigated and reported above.

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[6] F. F. Lucas, "An Introduction to Ultra-Violet Light Metallography," Proceedings of A.I.M.M.E., February, 1926.
[7] S. B. Leiter, "Annealing of Commercial Copper to Prevent Embrittlement by Reducing Gases," American Institute of Metals, February, 1926.
[8] P. D. Mercia and R. G. Waltberg, "Malleability and Metallography of Nickel and its Alloys," 1925, Technologic Paper No. 281, Bureau of Standards, Washington, U.S.A.

Company Meetings.

Park Gate Iron and Steel Company, Limited.—The annual meeting of this company was held at Sheffield recently. MR. CHARLES MARKHAM presided, and, in moving the adoption of the report, said they had been living in the past month in the most troublous times due to the coal position and the general strike. He thought that the trade unions had seen the error of their ways, and that the people of this country were not going to be tyrannised by any trade union organisation. It had been a big political move subsidised by foreign money, and the working people of this country were only just beginning to see what it meant. They wanted to obtain power, but British intelligence had come to the front. The coal position was one that affected the company very seriously. He gave figures relating to six South Yorkshire collieries for the month of April—a broken period. They raised 450,000 tons of coal and paid £229,000 in wages, or 10s. 2d. wages for each ton. That was divided among 18,000 workmen. Proceeding, he mentioned that during the past few years they had lost at Park Gate nearly £200,000 in strikes. That money had gone absolutely. It had gone to nobody, it had brought in no revenue, and it had brought nothing but misery and hardship.

Henry Hope & Sons, Limited.—The twenty-eighth annual meeting of the shareholders was held at Halford Works, Smethwick, Birmingham, last week. MR. H. DONALD HOPE (the chairman) presided, and in moving the adoption of the report, said:—The profit for the year ended March, 1926, is £41,237 13s. 7d. We brought in £19,396 18s. from last year, so that the total sum now available is £60,634 11s. 7d. We have already paid an interim dividend at the rate of 5½ per cent. per annum, free of tax, for the six months ended September 30, 1925, on the old 200,000 preference shares, and we propose to pay a further dividend, at the same rate, for the second six months on these shares; to pay at the rate of 5½ per cent. per annum, free of tax, for the three months ended March 31, 1926, on the 50,000 new preference shares; to pay a dividend at the rate of 10 per cent. per annum, free of tax, on the old 100,000 ordinary shares for the 12 months; and a dividend at the same rate for the three months ended March 31, 1926, on the 75,000 new ordinary shares. These dividends will absorb £23,562 10s. We issued on January 1 this year 50,000 preference shares at par and 75,000 ordinary shares at 10s. premium. The premium, amounting to £37,500, has been placed to the reserve fund, and we propose to add to this out of our disposable balance a further sum of £2,500, making the reserve fund £100,000. We propose to carry forward the balance of £32,866 to next year's accounts.

THE MÉTALLURGIE BASSET CO. report for the past financial year a further loss of 13,004 fcs., which makes the total loss 59,098 fcs. The recent general meeting of the Company decided to hand back to the other Basset concern, the Société Française des Aciéries Basset 20,000 shares to cover oncosts in connection with the realisation of patents. By the cancelling of these shares the capital of the Aciéries Basset is reduced from 60,000,000 fcs. to 50,000,000 fcs.

Some Notes on the Chemistry of the Cupola.*

By F. C. Thompson, D.Met., B.Sc., and M. L. Becker., B.Met.

The chemistry of the reactions involved in cupola practice is a considerably more complicated matter than would at first sight appear. The following short Paper is, therefore, presented more in the hope of stimulating thought and discussion than in that of adding a very substantial contribution to the subject. The data required before the matter can be really dealt with as a scientific problem is still largely lacking, and as a sequel to this preliminary review it is intended to carry out experimental work to attempt to fill up some, at any rate, of the more obvious gaps. Since the design of any furnace can be nothing but empirical until the fundamental chemical and physical principles involved are understood, the subject is of vital importance to the industry, and any contribution, however imperfect, may hope to add a little to the general store of knowledge. The authors would at the very start impress the fact that they have no wish to appear dogmatic in a field where dogmatism at the present time is irreconcilable with scientific treatment, but have presented a few points in the light in which they appear to them. They feel that it is in the interests of the industry to do this even if their ideas are proved incorrect, as the very fact that such proof is adduced will add to the store of fact available for future workers.

As an example of the indefiniteness of almost everything in this field it may be pointed out that even the details of the combustion of carbon are uncertain. It is generally held that this first burns to carbon dioxide, which later, by interaction with more carbon, is converted into the monoxide. The view is held by some very eminent chemists, however, that carbon monoxide is the first stage of the reaction, and, so far as the cupola itself is concerned, the available data is by no means conclusive. So far as it goes, however, it tends to fall into line mainly with the older view. Rhead and Wheeler (1) appear to have shown reason to believe that both oxides are formed simultaneously, and this middle course may well prove to be the correct one. The matter is clearly of first-rate importance, and any light thrown on it in the discussion will be of the greatest value.

As an introduction to the subject, it has been thought well to attempt to draw up a thermal balance-sheet for a typical cupola. It is not, of course, the first time that this has been attempted, but in so many cases the attempt has been done with inadequate completeness. Such a balance properly drawn up cannot but indicate the lines on which fuel may be saved and thus afford possible suggestions to designers and others.

The Thermal Balance of the Cupola.

The heat developed by the combustion of the coke can be readily calculated if the calorific power is known together with the composition of the escaping gases.

Let W be the weight of coke burnt per unit time.

Let C.P. be the calorific power of the coke.

Let 1/y be the fraction of the carbon burnt to CO, and 1-1/y or (M-1)/y be the fraction of the carbon burnt to CO_2, then the heat generated per unit time is approximately:—

$$W \times C.P. \times \frac{y - 0.7}{y} \qquad (I)$$

Now this heat is divided in many ways. In the first place there is:—

(i) That used in raising the pig-iron to its melting point, melting it, and then raising the molten iron to the tapping temperature.

(ii) The heat required to raise the temperature of the escaping gases to the temperature at which they leave the stack.

(iii) Heat is also expended in forming the slag, melting it and raising its temperature to that at tapping.

(iv) The heat lost by radiation from the walls of the cupola.

In this survey we have considered the conditions during the period after the cupola is running uniformly, and have not considered the heat required initially to raise the temperature of the brickwork, nor have we considered the bed-coke.

Now, there are not available all the data required to work out this theoretical heat balance in detail, and we shall have to be satisfied with approximations in many cases. These can, however, be predicted with an accuracy which is sufficient for the present purpose, namely, the determination of the main sources of wasted fuel.

Let us now take items (i) and (iv) in turn and attempt to determine their magnitude.

(NOTE.—The C.G.S. system will be used for convenience throughout.)

(i) Let M be the weight of iron melted per unit time.

Let s be the mean specific heat in the solid state.

Let l be the latent heat of fusion.

Let s′ be the mean specific heat in the liquid state.

If t is the melting temperature and T that of tapping, then the heat required for this portion of the work of the cupola is:—

$$M[s \times t + l + s'(T - t)]$$

It would appear that the mean specific heats in both the solid and the liquid states are not far from 0.15, while the latent heat of cast iron, though very uncertain, may be taken as of the order of 30.

Thus (i) becomes equal to $M(0.15\,T + 30)$.

(ii.). To burn W gms. of coke per sec. of which the percentage of ash is a, *i.e.* a weight of carbon of $W\frac{(100-a)}{100}$ requires 4/3 this weight of oxygen if the combustion is to CO and 8/3 the weight if to CO_2. If the fraction burnt to CO is 1/y, then the weight of oxygen needed is $W\frac{(100-a)}{100} \cdot \frac{8y-4}{3y}$

The weight of nitrogen introduced with this oxygen is then $\frac{77}{23} \cdot W\frac{(100-a)}{100} \cdot \frac{8y-4}{3y}$

The weights of CO and CO_2 formed are respectively $\frac{(100-a)}{100}\frac{W}{y} \cdot \frac{7}{3}$ and $W \cdot \frac{y-1}{y} \cdot \frac{11}{3} \cdot \frac{(100-a)}{100}$

The specific heats at constant volume of these gases are very nearly the same, and from room temperature to, say, 400 deg. C. may, nearly enough, be taken as 0.25. Further, they vary comparatively little with temperature. It may be worth pointing out that water vapour has a specific heat about double this value.

If now t′ be the temperature of the gases as they leave the stack, the heat represented by (ii) becomes nearly:—

$$\frac{W\,(100-a)\,t'}{400} \cdot \left[12.6 - \frac{5.8}{y}\right]$$

(iii) So far as the slag is concerned, there are no very reliable figures for the heat of formation and the latent heat of fusion. It is probably sufficient to assume that, taking the heat of formation and the latent heat together, there will be an evolution of about 50 calories per gram of slag formed. This figure may be arrived at in two ways. Akerman (2) obtained for the total heat of fusion of slags of the nature of cupola slags the value of approximately 370 cals. There is not much doubt that the specific heat is of the order of 0.3. At a temperature of around 1,400 deg. C. there will be some 420 cals. needed, and the difference of this figure and the 370 represents the net heat evolution due to the combined formation and fusion. A calculation made by Mr. E. O. Jones, A.R.S.M., has also yielded an almost identical figure.

For item (iii) in the balance-sheet we shall not then be far from the truth in putting this at:—

$m(0.3T - 50)$, where m is the weigat of slag formed.

* A Paper read before the Annual Conference of Institute of British Foundrymen.

The production of burnt lime from the limestone charged involves a certain absorption of heat. The value of this is:—

$m' \times 451$ cals. per gram, where m' is the weight of limestone charged.

The total value of (iii) thus becomes:—

$$m(0.3T - 50) + m' \times 451$$

The radiation loss and certain other small items must now be considered. The latter involve such matters as the dehydration of the charge, the water-gas reaction from the steam so generated and that in the blast, the cooling due to the expansion of the blast as it enters through the tuyeres and loss of pressure.

Both theoretically and experimentally it may be shown that in a well-lagged cupola the radiation loss is negligible, being certainly less than 1 per cent. of the heat generated by the coke, and probably very much less. The theoretical treatment need hardly be given here, but as an experimental verification of the fact, the figures may be cited of Piwowarsky and Broglio. (*) For their standard cupola the radiation and conduction loss was 10.4 lbs. of coke per hour compared with a total consumption of 2,150 lbs. per hour, *i.e.*, about one half per cent. It is clear that this source of loss is practically negligible. The water present is difficult to deal with, and in all probability is not important, though there can be little doubt that the dryer and hotter the air the better. Even slight increases in blast temperature may be expected to result in appreciable economies. The cooling of the blast on entry into the furnace for the pressures used in cupola practice can be neglected.

We have thus evaluated the various factors of a physical nature which operate in the cupola, but there is one source of heat which we have neglected, namely, that due to the oxidation of iron and of the constituents in the pig. For each gram of silicon oxidised there is a heat evolution of 6,400 cals., of iron (to FeO) 1,170, and of manganese 1,650 cals.

Let p, q and r be the percentages of these elements respectively which are oxidised, then the heat evolved will be:—

$$\frac{M(6{,}400p + 1{,}650r + 1{,}170q)}{100}$$

Suppose p to be 0.25, r 0.1, and q 1, then this becomes $M(16 + 1.65 + 11.7)$, *i.e.*, nearly 30 M.

We are therefore left with the relationship:—

$$\text{W. C.P.}\frac{y-0.7}{y}0 + \lambda = M(0.15T + 30) + \frac{W(100-a).t'}{400} \cdot \left[12.6 - \frac{5.8}{y}\right] + m(0.3T - 50) + 451\,m' - 30\,M \quad \text{(A)}$$

Now m' will be about 0.9 m.
And m normally about 0.04 M.

The C.P. of a typical coke may be taken as 7,000 cals., and a as around 12½ per cent.

As a check, and thus to determine whether the values for the various thermal constants chosen are reliable, the result may be used to determine the melting ratio for a typical case. That chosen is for a composition of escaping gases containing equal volumes of the two oxides of carbon and a temperature of about 425 deg. C. With otherwise the same meanings and values for the factors as before, the ratio of the weight of metal tapped at 1,425 C. to that of the coke with 12½ per cent. of ash used is 15.4. This is clearly a reasonable figure, and indicates that the constants adopted are near to the truth, sufficiently so at any rate for the qualitive use of the equation for determining the relative effect of each part of the process. Incidentally equation A is also useful as giving the theoretical limit to which coke economy could be pushed in the ideal case where the escaping gases were at the same temperature as the foundry and contained no carbon monoxide at all. In this limiting case, which, of course, can never be expected in practice, it would be possible to melt a ton of iron and tap it at 1,425 deg. C. with a coke consumption of only just over two-thirds of a cwt.

To illustrate the effects of the completeness of the combustion of the carbon, the temperature of the escaping gases and the tapping temperature, Figs. I, II and III have been plotted. They are self-explanatory and need no elaboration.

It is now possible, making the same assumption as before—*i.e.*, tapping temperature of 1,425 deg. C., temperature of the gases 425 deg. C., and CO/CO_2 ratio=1—to get an idea of the relative amounts of heat used for the different purposes, as shown in the following table:—

For heating and melting the metal	52.6 per cent.
For heating and melting the slag	6.8 per cent.
Lost in gases	47.1 per cent.
Lost by radiation, etc.	0.3 per cent.
Gain by oxidation of iron, etc. ...	6.8 per cent.

Of the heat required for the slag about one-half is used to burn the limestone.

The real efficiency of the cupola as an iron melting apparatus may be measured by the ratio of the heat in the molten iron to that absorbed as a whole. The figures just given show that the efficiency on the basis of the heat from the coke burnt is 52.6 per cent. On that of all the heat provided, however, both from the coke and from the exothermic reactions this is reduced to about 49.1 per cent.

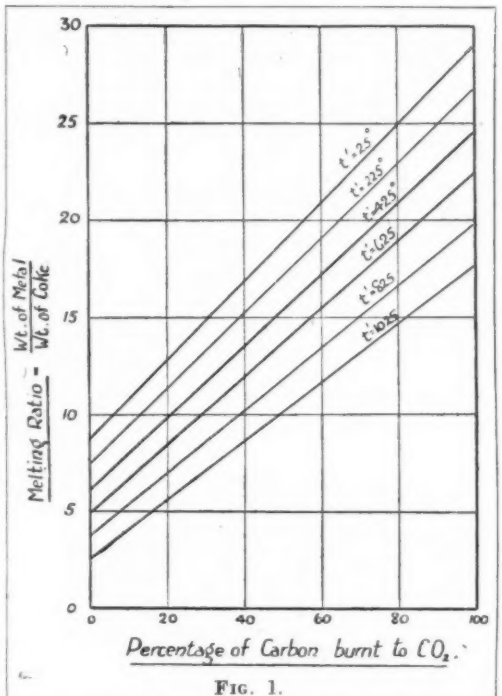

FIG. 1.

Theoretical efficiency of cupola plotted against the percentage of carbon burnt to CO_2 for various temperatures (t') of escaping gases and for a constant tapping temperature of 1,425 deg. C.

Now clearly the only possible sources of economy lie in the heat actual or potential lost in the gases, about one-half of all the heat which could be generated by the coke, and the slight gain by the use of burnt lime. We may now proceed to discuss what appears to be possible in these directions.

Reactions with Carbon.

It has already been pointed out that the course of the reaction between carbon and oxygen at high temperatures is far from certain, and the most probable effect is that both oxides of carbon are formed. That CO_2 is the main product at first is generally supposed and is in agreement, for instance, with the analysis of the gases recorded by Piwowarsky and Broglio taken at the tuyere level. These gases consisted of:—

CO_2	CO	O_2
15%	0.5%	7%

This reaction is highly exothermic, and is followed by a further reaction between the carbon dioxide and the hot coke, in which carbon monoxide is the product. This absorbs a great deal of heat and tends to set a limit to the hottest zone of combustion. There is evidence, however, that the reversion to carbon monoxide may not be so complete as is often imagined.

The gases as they leave the zone of combustion pass into the cooler portions of the furnace and

in contact with the relatively cool charge give up a portion of their heat. Now, when in equilibrium, a mixture of carbon monoxide and dioxide tends, as the temperature falls, to change its composition so that a definite amount of each gas is present at a definite temperature. This would tend to cause in the stack a gradual disappearance of carbon monoxide and its conversion into the dioxide. It is true that under the conditions which obtain in the cupola where the ascending gas stream is moving with a high velocity, equilibrium cannot be attained, but there will be the tendency for this to happen. The result will be that if AB of Fig. 4 represents the equilibrium content of carbon dioxide at the various temperature zones of the cupola, taking into consideration the nitrogen present, the actual amount of this gas AD will lag behind, or, in other words, the composition of the gases will be that characteristic of a temperature higher than that which actually obtains at the particular level.

Now, two things may cause the gas mixture to approach more nearly to the equilibrium condition. In the first place catalytic agents may be present, and it is known that iron itself has a definite effect in this direction. Secondly, as the time for which the gases are enabled to react

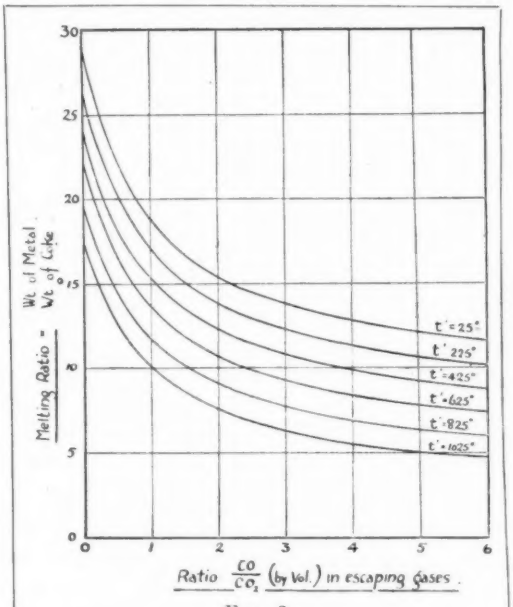

FIG. 2.

Thermal efficiency of cupola plotted against the ratio $\frac{CO}{CO_2}$ (by vol.) in the escaping gases for various temperatures (t') of the latter and for a constant tapping temperature of 1,425 deg. C.

is increased the tendency to approach the equilibrium composition will also be increased. This is effected by reducing the speed of the gas stream, *i.e.*, the blast pressure. This conclusion may be checked, and is valuable as affording a confirmation of this reaction in the stack. It appears to be quite generally agreed that rapid melting is incompatible with fuel economy. Osann (4), for instance, and Korevaar (5) both accept this position. It is, of course, true that the slower gas stream will have more time to transmit its heat to the charge by radiation and hence to leave the cupola at a lower temperature, but the chemical effect is also present. It may be thought that the various published analyses of gases from various positions in the cupola would avail to establish the truth or otherwise of these ideas, but the authors feel that there is no evidence of any set of analyses being available which impress them as being completely reliable. The depth of immersion of the sampling tube into the furnace, changes of composition of the gases with time, and so many other factors come into the experiment that considerable precautions, not generally taken, are required before satisfactory results would be obtained.

To revert to the question of the rate of ascension of the gases, not too high a blast velocity is obviously required, while as an additional assistance the area of the stock may be enlarged above the combustion zone. Some cupolas have been designed on these lines, and although practical points may arise which render them unsatisfactory, and with such we have intention of dealing, yet the shape is one in accord with the demands of physico-chemical theory. The more slowly, then,

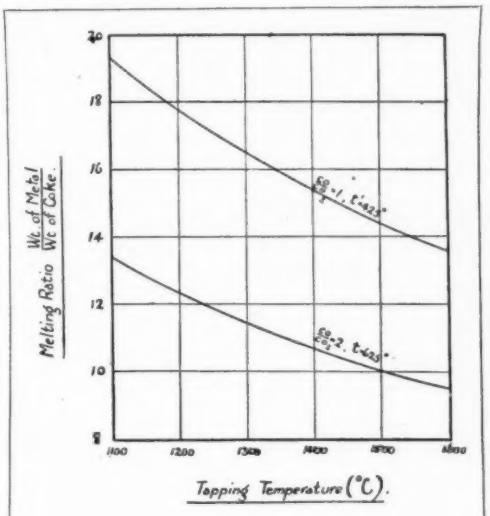

FIG. 3.

Effect of tapping temperature on melting ratio.

the gases rise through the stack, the more complete will be the heat transference to the charge and the lower will be the loss due to the escape of carbon monoxide.

Related with this is the question of the height of the stack. Clearly a cupola so short that the gases were still very hot at the charging door

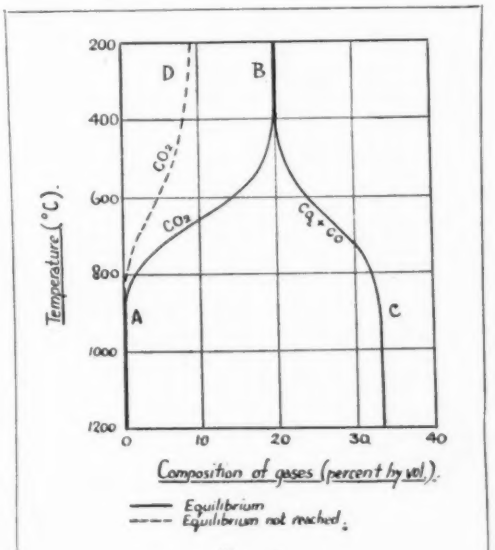

FIG. 4.

Effect of temperature on the equilibrium between carbon and a mixture of CO_2, CO and N_2, resulting from the combustion of carbon in air (calculated for the atmospheric pressure).

would be bad both from the point of view of the direct heat thus lost and also from the fact that the conversion of carbon monoxide into the dioxide and carbon does not occur to any marked extent until a temperature of about 700 deg. C. is reached. The reaction ceases around 400 deg. C., and from this point of view the cupola should be so designed that with normal working the gases, as they leave the charge, should not be at a higher

temperature than this. The economy which can be obtained by reducing the temperature still further is less than that brought about by the previous reduction, since from now onwards the economy can be only that resulting from a more perfect transference of sensible heat to the charge, and no further saving can be effected by a reduction of the carbon monoxide. If the conclusion be accepted and working from the fundamental assumption that in the stack, carbon monoxide is gradually converted into the dioxide, there is little chance of escaping it, one very definite practical fact emerges. For a given output of iron per hour the fuel consumption will be less in a large cupola with a low-velocity blast than it will be in a smaller one in which the blast pressure is higher. It would be of great assistance to know whether or not this can be substantiated.

Porter (6) agrees with these results and states that, from the point of view of economy, "increased height of cupola has been shown to rest upon a sound theoretical basis, while the results of practice indicate that it accomplishes the results desired." We wish to stress the fact that such economy is not merely the result of more perfect transference of heat to the charge, but is also that of a more perfect combustion of the coke to CO_2. During the final stages of a blow after charging has ceased and the effective height of the furnace is diminished, there is not only an increase of temperature of the escaping gases, but also an increase in the percentage of carbon monoxide in these gases.

Lime or Limestone.

It has already been seen that the limestone added will, at a certain temperature, be converted into lime and carbon dioxide, and that this reaction absorbs an amount of heat which is more or less equal to the whole of the heat otherwise required for the formation and heating of the slag. The substitution of lime for the unburnt limestone would remove the necessity for the provision of this heat, and lime having a lower specific heat than the carbonate, less heat would be required for its heating to the temperature of decomposition. The heat absorption, in the atmosphere which obtains in the cupola, takes place about 800 deg. C. and thus produces a cooling effect around the very temperature at which the reaction by which carbon monoxide passes over into the dioxide with the deposition of carbon tends to take place. Further, the evolution of a relatively large volume of carbon dioxide can only have a deleterious effect on the extent to which this latter reaction can occur. The monoxide is at a temperature at which it is tending to be changed in part into the dioxide, and the further the CO content of the gases is from the equilibrium content at the temperature, the more rapid would the change be expected to be. The dilution of the gases with CO_2 must reduce the rate at which the latter gas is formed, and as a result cause the escaping gases to be richer in the monoxide. It thus follows that although a direct economy of the order of rather more than 2 per cent. of the total coke charged would be effected by the substitution of lime for limestone, there is also an indirect effect, the degree of which it is difficult to gauge, but which may well be far more appreciable, in the better combustion of the fuel to the dioxide. It is in the latter direction particularly that real economy is to be looked for. In any case it appears to be uneconomical to use expensive foundry coke to burn lime, which is essentially what is at the present time being done.

Since it is difficult to store quicklime for any length of time without it becoming slacked, it becomes necessary to consider the effect on the fuel economy of the cupola of the addition of the latter form. In the first place, the heat required to convert this into quicklime is, for the same weight of lime, only a little more than half that required for the decomposition of the limestone. Against this, however, must be put the fact that the specific heat of slacked lime is about 1.8 times that of the carbonate. Neither of these facts, however, appears to be of much importance, since the temperature at which the dehydration of slacked lime takes place is about 450 deg. C. This is a temperature around which the reaction

$$2CO \rightarrow CO_2 + C$$

essentially ceases, with the result that heat taken from the stack at this point is more or less immaterial from the point of view of efficient combustion of the fuel. Even slacked lime, then, has two advantages over limestone. In the first place, as a result of its relatively low temperature of decomposition, it absorbs its heat outside the important temperature range, and secondly, it does not throw into the gases a gas which retards the formation of carbon dioxide from the monoxide. Both facts will tend to accelerate the rate of formation of carbon dioxide. We do not know any full statement of the effects of substituting lime for limestone in the cupola, and if the experiment has not been carefully tried it would appear to be well worth investigation. There are many cases on record where in the blast furnace, generally of small dimensions, economy has followed the substitution, and these confirm from the chemical point of view the suggestions made. There is also one point in connection with design which would follow from the use of lime. Since the cooling effect well up in the stack would be eliminated, the height of the furnace would, for equal efficiency in so far as the temperature of the escaping gases was concerned, require to be raised.

Reactivity of the Coke.

In blast furnace circles particularly, much has lately been written concerning the effect of the "reactivity" of the coke on the fuel consumption. It is not, perhaps, out of place to examine very briefly the problem from the point of view of cupola practice. The authors, however, tread with diffidence, since the question is one of more than usual difficulty and uncertainty.

The reactivity of coke is measured, as a rule, by the etxent to which at any temperature it has the power of reducing carbon dioxide to the monoxide. This is largely determined by the size and porosity, the smaller and more porous materials doing this to a greater extent than the larger and denser ones. At the same time there is some other factor, since size and porosity alone do not completely determine the result. As the temperature rises this reactivity also increases, and at the temperature of the melting zone of a cupola there can be very little difference in this respect between the cokes which may be used as a result of their other physical and mechanical properties. If then there is to be anything in the question of reactivity, it must lie chiefly in the behaviour of the coke at the lower temperatures.

Much of what has been written in connection with this subject appears to suffer from serious inconsistencies. Arend and Wagner, (7) for instance, say that for a given temperature the stability of carbon dioxide in the presence of coke will be diminished as the reactivity rises. This being true at all temperatures it should follow that the escaping gases must be richer and richer in carbon monoxide as the reactivity of the coke is raised. This, however, is a rather one-sided way of looking at the matter, since although what has been said is true so far as it goes, it holds when, and only when, the concentration of carbon dioxide exceeds the equilibrium content at that temperature. The effect of the reactivity of the coke is more or less catalytic, and merely accelerates the rate of approach to, but not the value of, the equilibrium composition. It must not be forgotten that as a result of the high speed of the ascending gases and the relatively low velocity of the reaction—$2CO \rightarrow CO_2 + C$—the composition of the gas inside the cupola at any level does not correspond with the equilibrium at the temperature but to one at a much higher temperature. All this is leading up to the point that in the stack of the cupola itself the gases are always richer in carbon monoxide than corresponds with the equilibrium value, and are thus on the opposite side of this equilibrium from that thought of in connection with the usual measurement of reactivity. In a catalytic change the catalyst alters the rate of approach to equilibrium only, and it would thus appear that a reactive coke, just as it accelerates the rate of conversion of carbon dioxide to carbon monoxide, should equally increase that from the latter oxide to the former when the conditions are reversed. If then reactivity means anything at all in cupola practice, and that is a matter which can be determined by experiment only, a reactive coke should

be chosen. Indeed, if such a fuel does bring about economy in the blast furnace, and there is general agreement on this point, there is no reason which the authors can see why it should not be equally beneficial in the cupola. The conclusion of Porter that the combustion in the cupola differs from that in the melting zone of the blast furnace appears to us to be based on unsound fundamentals.

The Addition of Further Air Through Auxiliary Tuyeres.

Above the zone of combustion there is undoubtedly a considerable amount of carbon monoxide in the gases. It is but natural, therefore, that the suggestion should have been made and repeatedly tried experimentally that this CO might be utilised by blowing in at a level appreciably above that of the tuyeres a further supply of air. If, however, this is done the obvious result is merely to reproduce more or less the conditions which obtain at the tuyere zone. Much heat is generated at a relatively high level in the furnace, and cannot be transferred to the charge, with the result that the escaping gases will be raised in temperature correspondingly. This will also tend to reduce the lower temperature transformation of carbon monoxide to the dioxide. Even if on the whole the gases do contain a little more carbon dioxide, and even on this point the evidence is not clear, any gain by this rather more perfect combustion may be more than lost by the greater loss of "sensible" heat in the gases. The conclusion can hardly be escaped that what air is required for combustion should be blown in at the tuyeres to keep the zone of combustion as low as possible.

Recalling what has already been said concerning the equilibrium between carbon mon- and di-oxide at high temperatures, it will be realised that the whole argument for auxiliary tuyeres rests on a fallacious basis. At tuyere temperatures the equilibrium is one in which almost the whole of the gas tends to become CO. The addition of more air may temporarily convert some of this into the dioxide, but this, by interaction with more carbon, will pass again into the monoxide stage. The net result will be the same as if the air had burnt not the carbon monoxide, but more coke. This clearly, when taking place high up in the stack, can only lead to wasted energy.

It may incidentally be worth pointing out that in the absence of excess carbon and at, say, 1,650 deg. C. (a temperature which may very well be reached by the hottest gases), there is not complete combustion of carbon monoxide in oxygen, about 1 per cent. of the dioxide formed remaining as carbon monoxide and oxygen. As the temperature falls, however, the latter will rapidly decrease to immeasurably small quantities.

After the above was written the authors' attention was drawn to the Paper by Porter already mentioned. His ideas and ours, though, reached independently, are in such perfect agreement on this point that we venture to quote them. "A second row of tuyeres," he says, "is supposed to effect the more complete combustion of the carbon by the addition of oxygen at a point where it can burn the CO. Theoretically this appears to be an excellent idea, but actually it usually fails to accomplish the result desired, *i.e.*, to materially decrease the proportion of CO, though it may produce other desirable effects."

"Since CO is not formed directly at the tuyeres but only at some distance above or in front of them, it is evident that the second row of tuyeres must be located a considerable distance above the lower ones in order to reach the CO. Now if this is done the result is to produce another zone of combustion and a practical duplication of the conditions at the lower tuyeres. Where the addition of a second row of tuyeres has proved advantageous the benefit can usually be traced to the enlargement of the total tuyere area and the consequent greater volume of air admitted to the cupola."

J. E. Hurst ([8]) has also recorded his conclusion, drawn from actual test, that auxiliary tuyeres are not, in a properly designed cupola, of advantage.

With regard to the amount of air which may reasonably be injected, it would appear safe to believe that, from the point of view of fuel economy, that amount is needed which will, under the working conditions, just fail to show free oxygen in the escaping gases. So far as the authors can see, this should lead to the most perfect combustion which can be produced under the conditions obtaining in any given cupola.

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([4]) Osann, Stahl u. Eisen, 1925, p. 2147.

([5]) Korevaar, "Combustion in the Gas Producer and Blast Furnace" (1924).

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([7]) Arend and Wagner, "Revue de Metallurgie," XXI (1924), p. 585.

([8]) Hurst, THE FOUNDRY TRADE JOURNAL, March 4, 1926.

Detinning Tinplate Scrap.

At the annual meeting of the American Electrochemical Society, held at Chicago recently, and reported in "The Iron Age," a "Symposium on Chlorine" was held at which MR. C. L. MANTELL reviewed the latest developments in the recovery of tinplate scrap in a Paper entitled "Utilisation of Chlorine in the Recovery of Tin and Tin Salts from Tinplate Scrap." He remarked that chlorine detinning of tinplate scrap with the production of tin or tin salts was becoming rapidly of greater importance. This was caused by the great increase in the production of tinplate and tinplate containers, the increase in tin prices and the relative tin metal shortage. Many of the chemical and electrochemical processes of detinning originally tried were failures, as were most of the mechanical processes. Three processes, however, had operated successfully in recent years, and had been more or less in competition with one another for the last 40 years, during which time one or another of these had ultimately gained predominance, due to refinements in that process over the others. These three processes were the electrolytic alkali process, the alkali chemical process and the chlorine process.

The most important modifications of the chlorine process, continued the author, are those of Goldschmidt, Sperry, Acker and Von Schutz. In the Goldschmidt process, chlorine is introduced in the detinning chamber under pressure, which causes the reaction gas to penetrate all parts of the scrap material. In the Von Schutz process a dry mixture of chlorine diluted with other gases, such as dry air, is drawn through the scrap by suction. This process has the advantage of having the shorter detinning time, simple apparatus and little manual handling. In the Acker process liquid chlorine, which continually sets free chlorine gas, is used as the detinning agent. Sperry, on the other hand, uses mixtures of stannic chloride and chlorine in the presence of stannic chloride, usually in a closed system. In general, the chlorine process has advantages over the electrolytic method as it can be carried on in larger units and the labour charges are therefore materially reduced. The detinning is also somewhat more thorough and less tin is lost.

Plants for the recovery of tin from tinplate scrap are fairly simple. The cost will vary considerably with the size of the plant, from $15 to $20 (62s. 6d. to 83s. 4d.) per ton of scrap handled for a yearly capacity of 1,500 tons to as low as $8 to $10 (33s. 6d. to 41s. 8d.) per ton of scrap handled in a plant taking care of 10,000 tons per year. Tinplate scrap has no market as such, but on the other hand, detinned scrap has a ready sale. Stannic chloride crystals are in constant demand and saleable at an attractive price. If the manufacturer desires, tin metal can be recovered from the chloride with a good margin of profit. There will be consumed approximately 80 to 100 lbs. of chlorine per ton of tinplate of equality and weight of tin coating on tinplate commercially used for cans. The amount of scrap resulting from the manufacture of tin containers alone is tremendous. With increasing prices of tin, the recovery of tin becomes of greater and more pressing importance.

Results Obtained in the Improvement of the Qualities of Cast Iron.*

By Louis Piedboeuf.
[*Belgian Exchange Paper.*]

High-tensile cast irons generally have a structure that is almost entirely pearlitic, though sometimes high strengths are obtained with cast irons having a pearlitic and ferritic structure, provided the graphite is distributed in sufficiently fine lamellæ.

Maurer's cast iron diagram may be very useful for classifying and comparing the various high quality cast irons. This diagram subdivides the cast irons according to their texture, in terms of carbon and silicon content. It was suggested for the first time by Engineer Maurer, of the Krupp Works, in a Paper on high-tensile cast irons as produced by Krupp. He was dealing, of course, with good machinery castings, having a phosphorus content usually below 0.60 per cent., with 0.50 to 1.0 per cent. manganese. In cast irons of this kind, the structure depends on the carbon and silicon contents, assuming, of course, that the speed of cooling is kept within certain limits.

The diagram (Fig. 1) is plotted by giving the carbon contents in terms of silicon. The horizontal line HH′, at 1.7 per cent. C., shows the limit between cast iron and steel. The point B is determined from the assumption that steels containing 2 per cent. of silicon may be cast without graphite forming. The point C, with 7 per cent. silicon, is derived from Guillet's researches on silicon steels. The point A corresponds to the eutectic containing 4.3 per cent. of carbon.

B is projected to B′ on the line HH′; and D, which is the intersection of AC with HH′, is projected on the abscissæ, when it will be found that

CAB = the region of white cast iron.

BAD = the region of pearlitic cast iron.

Above AD is the region of ferritic and graphitic cast irons.

BAB′ = region of cast irons intermediate between white and pearlitic cast irons—those which contain pearlite and cementite, *i.e.*, mottled irons.

DAD′ = the region midway between pearlitic and ferritic cast irons, *i.e.*, those containing pearlite and ferrite.

B′AD′ = the region of pearlitic cast irons.

This diagram, plotted from theoretical considerations, has been verified by numerous examples in practice, nearly all of which have confirmed the correctness of it. The diagram may be checked by any laboratory having available the results of chemical analyses and micrographic investigations.

Maurer included in his diagram cylinder cast irons and Krupp special cast irons, as also the results of laboratory tests carried out by Wüst and Bardenheuer. The appended diagram has been supplemented by points showing a whole collection of special irons, pearlitic irons, and semi-steels.

The point F (see Fig. 1) corresponds to information given by Bauer in 1923 to characterise (distinguish) pearlitic cast irons obtained by the Lanz process. Not much data have been published on this method. In a Paper published in "La Fonderie Moderne," August, 1925, Monsieur Buffet, engineer of the Société Alsacienne, gives as the distinguishing feature of the Lanz pearlitic cast irons: C + Si = 3.8 to 4.2 per cent. The corresponding zone in the diagram is that included between the two parallel lines OP and MN. Part of it comes within the space occupied by the mottled irons, *i.e.*, those with an excess of cementite. This is quite as it should be, because, in the Lanz process, the pearlitic structure is obtained by heating the mould.

The circle KC circumscribes Krupp steam engine cylinder irons, and the zone KS the special high-tensile irons of the same firm.

Point E is derived from data published in 1924 by Emmel for pearlitic cast irons as produced by the Thyssen Company. These cast irons are distinguished by Si = Mn = 1.

The one *crst* included between the lines C + Si = 4.2 and C + Si = 4.5, and the zone marked *Pr* differentiates two types of semi-steel cast iron[1] as suggested by Lieut-Col. Prache.

Point X indicates the composition of a special semi-steel cast iron used for aerial bombs, and suggested by Cameron.[2]

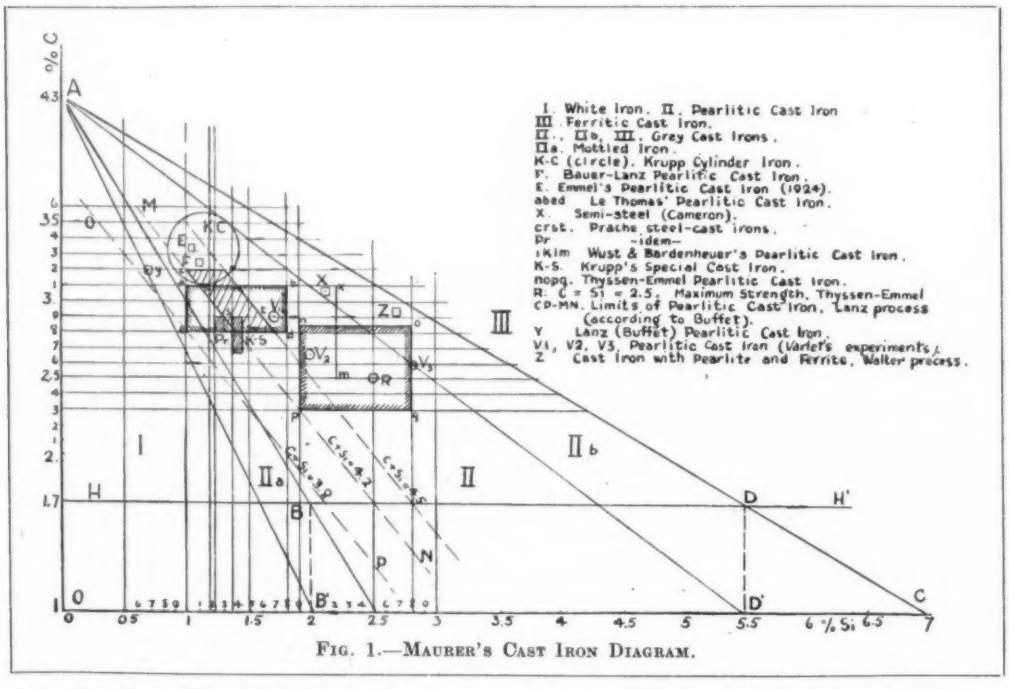


FIG. 1.—MAURER'S CAST IRON DIAGRAM.

* A Paper read before the Annual Conference of Institute of British Foundrymen.

[1] Liege Congress, 1922.
[2] Birmingham Congress, 1923.

The zone included within the rectangle *abed* is that of the pearlitic irons as produced at the Indret works, and as given in a very interesting Paper[3] published by Monsieur le Thomas.

The rectangle *iklm* is derived from the laboratory researches of Wüst and Bardenheuer.

The zone *nopq* is the region of cast irons produced by the Thyssen-Emmel process. These cast irons are said to give the best results from the

FIG. 2.—SPECIMEN V3 AT 200 DIAS. ETCHED WITH PICRIC ACID.

T.C., 2.61; C.C., 0.77; Si, 2.82 per cent.; and Brinell hardness, 206 to 214.

point of view of evenness of texture and strength.

The points V_1, V_2 and V_3 indicate the results of a test kindly made, at the author's suggestion, by M. Varlet (Vice-President of the Belgian Association) at the foundries of the Société Espérance-Longdoz. It is due to his courtesy that the author is able to present some interesting specimens of high-tensile cast irons. A photo-micrograph of the cast iron V_3 is shown in Fig. 2.

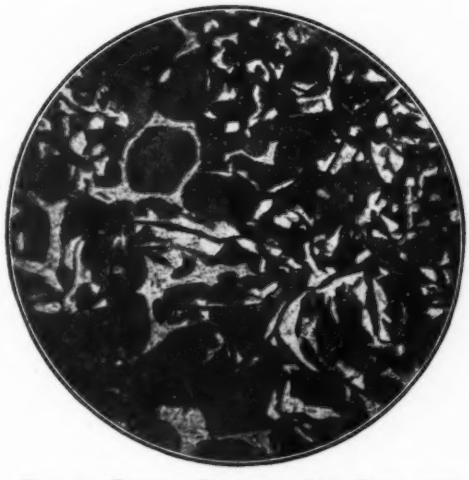


FIG. 3.—FERRITIC-PEARLITIC CAST IRON WITH THE GRAPHITE IN FINE NODULES.

Tensile strength, 15.8 tons per sq. in.; Brinell hardness, 170 to 180; Gr., 22.51; C.C., 0.42; Si., 2.73; Mn., 0.41; P., 0.87, and S., 0.04 per cent. x 200 dias.; etched picric acid.

In order to distinguish the cast irons of zone 2*b*, there has been noted, at Z, a cast iron containing pearlite and ferrite, the analysis and micrograph of which are shown in Fig. 3.

It may be presumed that the researches carried out by the Société Alsacienne tend in the same direction, since, in his Paper quoted above, Monsieur Buffet mentions the production of cast iron containing 2.3 and 2.5 per cent. carbon.

Maurer's diagram clearly points out the advantage of low carbon-contents. The lower the carbon content, the wider the zone of pearlitic structure. There is thus greater certainty of getting the pearlitic structure without the risk of encroaching on adjacent zones. By keeping at an equal distance from the cementite and ferrite zones, there is a greater chance of getting the pearlitic structure without heating the mould.

For the cast irons included in the zone *abed*, Monsieur le Thomas states that an endeavour should be made to keep a slight excess of cementite so as to be sure of attaining the pearlitic structure. With low carbon contents that is not necessary, and there may even be a slight excess of ferrite without fear of modifying the structure and the tensile properties, as will be seen from the results obtained with the V_3 cast iron. In this case, there is the added advantage of a lower hardness and better machining properties.

Another advantage of the low-carbon one is that, in this zone, the pearlitic structure will be attained much more independently of the speed of cooling.

As a matter of fact, the effect of rapid cooling (by chill-casting or in light castings) may easily be represented by a displacement to the right of the zones I and IIa; and slow cooling (by casting in a hot mould, or in heavy castings) by a displacement to the left of the zones III, IIb and II. It will readily be seen that the points situated towards the middle and bottom of the rectangle *nopq* will be least affected by these changes.

The test-pieces 220 mm. square, cast with the cast iron represented at V_3, has an even texture

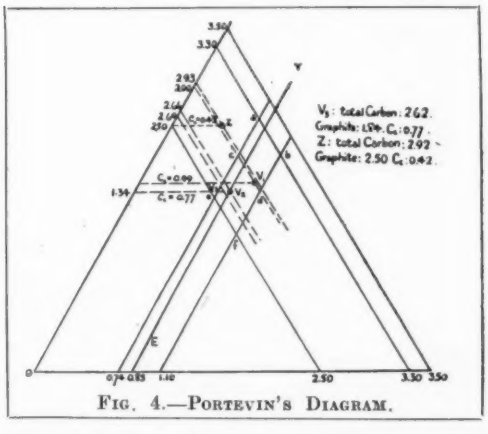


FIG. 4.—PORTEVIN'S DIAGRAM.

throughout its cross-section. In the higher-carbon machinery cast irons, a considerable increase in the graphite lamellæ will always be found towards the centre, even where the diameters are smaller. With low-carbon and high-silicon pearlitic cast irons it is possible to obtain an identical texture in the thin parts and the thick parts of the same casting.

This regularity of texture may be explained as follows:—The primary graphitisation persists for a certain time and takes place during a definite interval of temperature, after solidification. As in the case of secondary graphitisation[4], we may assume that its rate will be proportional to the silicon content. At the same time, owing to the lower carbon content, graphitisation will be completed more quickly. In the case of cast irons of the Thyssen-Emmel type, graphitisation would be extremely rapid and practically complete before the effect of the walls has had time to make itself felt and cause appreciable cooling of the thin parts of the casting.

Maurer's diagram classifies cast irons according to their carbon and silicon content, without taking into account the percentage of combined carbon. Referring to Portevin's diagram (Fig. 4), it will be seen within what limits this content may vary for pearlitic cast-irons and semi-steels. Assuming the carbon content to be the same, the percentage of combined carbon will be inversely proportional to the silicon content. For each composition of cast iron, there is only one percentage of combined carbon corresponding to the ideal pearlitic structure (C = 0.90 per cent. for pure pearlite).

[3] "La Fonderie Moderne," Feb., 1926.

[4] Researches of Charpy and Grenet.

The corresponding percentages of combined carbon for cast irons the total carbon of which varies between 2.5 and 3.3 per cent. are situated on the line EY of Portevin's diagram. Adding to this diagram the points corresponding to samples V_1, V_3 and V_2, it will be seen that V_1 has an excess of cementite, V_3 comes practically on the line EY, and V_2 has an excess of ferrite.

Finally, the cast iron characterised by the point Z comes on to Z in the diagram, i.e., the pearlite *plus* ferrite zone. Contrary to what Monsieur le Thomas states in his Paper read at the Liége Congress, it is possible to get high-tensile cast irons even in this region of Portevin's diagram.

The zone *abcd* distinguishes more particularly the so-called semi-steels, and *cdef* pearlitic cast irons proper.

The pearlitic texture alone is not sufficient to ensure high mechanical properties. There is another important point, *viz.*, the diminution in the size of the graphite lamellæ. Numerous researches have been carried out in this direction, as a result of which the size of the lamellæ has been considerably reduced by treating the metal in an oil or an electric furnace. According to Piwowarski's researches, it is principally by superheating the liquid iron that the finely distributed graphite is formed. The results obtained by Kerpely, and which are given in Tables I and II, show what is possible in this connection by treatment in the electric furnace.

From the practical point of view, there is another important factor contributing to the production of high strengths, and that is, to get sound castings. As Monsieur Ronceray has very rightly observed, it is soundness of the castings that should be primarily aimed at.

It would not be much use trying to reduce gaps caused by faulty distribution of the graphite lamellæ, if other discontinuities were allowed to persist in the shape of blow-holes, segregations, or internal stresses. In this connection, it is interesting to note that the cast iron represented by point Z of Maurer's diagram gives a tensile strength of from 15.7 to 17.6 tons sq. in., in spite of a phosphorus content of 0.8 per cent. This result was obtained by a purifying treatment carried out in the fore-hearth by alkaline substances. This cast iron is close-grained and the graphite in fine lamellæ. By protracted treat-

FIG. 5.—THE CENTRAL PART OF A MALLEABLE CASTING SHOWING THE GRAPHITE TO BE IN NODULES, AND PEARLITE × 200 DIAS., ETCHED PICRIC ACID.

TABLE I.—*Mechanical Properties of Various Special Irons.*

Bauer (Lanz System).						Krupp.			Remarks.
Test piece.	38/42 mm.	32/28 mm.	42 mm.	32 mm.	% increase.	15 mm.	36 mm.		
Transverse strength tons/sq. in. ..	32.3 (25.3)	34.2 (28.4)	27.2 (19.6)	31.7 (24)	20	40.8 (31)	38.9 (22.8)		
Deflection, mm. ..	13 (12)	17 (16)	10	13		8.8 (300)	18 (720)		
Tensile strength, tons/sq. in. ..	15.7 (12)	17.6 (13.8)							
Brinell hardness ..	160 (147)	173 (160)				230			
Thyssen-Emmel.						Kerpely.			Kerpely iron cast in electric furnace. Distance between supports for deflection: (a) & (b): 300 mm. (c): 600 mm. (d): 720 mm.
Test piece.	(a) 15 mm.	(b) 15 mm.	(c) 30 mm.	(d) 36 mm.		30 mm.			
Transverse strength tons/sq. in. ..	40.3	41	38.3—42.9	41—42		30.4 — 32.9			
Deflection, mm. ..	4.8—4	8.6—6	11—10	16.8—17.4		10—10.5	(On length of 600 mm.)		
Tensile strength tons/sq. in. ..	20.2					19 to 22.1			
Brinell hardness ..	240 to 310								
Le Thomas.						Varlet.			Tests made on Frémont machines. In transverse test load was applied until specimen broke. (Figure is "total breaking load").
Test piece.	8×10 mm. sq.	Breaking load.	25 mm. diam.			8×10 mm.	Breaking load	25 mm diam.	
Transverse strength tons/sq. in. ..	31—33.6	700—750 kg.				41.8	935 kg.		
Shearing strength tons/sq. in. ..			15.8 to 17					29.4	
Tensile strength, tons/sq. in. ..	13.89 to 15.20					Elastic limit —731 kg.			
Brinell hardness ..	230					210—230			

TABLE II.—*Composition of Various High Tensile Irons.*

		C.	Si.	Mn.	P.	S.
1922	Wüst et Bardenheuer	2.5 to 3.10	1.20 to 2.20	0.70 to 1.20	0.30	0.00
March, 1923 ..	Bauer, Syst. Lanz	3.25	1.90	0.79	0.40	0.15
April, 1924 ..	Emmel	3.35	1.00	1.00	0.30 to 0.50	0.06 to 0.15
Nov., 1924 ..	Krupp	2.67 to 2.90	1.40	1.00	0.68	—
April, 1925 ..	Buffet, Syst. Lanz	C.+Si.=	3.80 to 4.20	0.80	0.10	0.10 max.
Jan., 1926	Kerpely	2.95 to 3.05	1.00 to 2.30	0.85 to 1.00	0.25 to 0.80	—
Feb., 1926 ..	Varlet	2.60 to 2.90	1.70 to 2.80	0.80 to 0.90	0.12	0.07 to 0.09

ment in the fore-hearth, in the absence of the impurities contained in the cupola slag, a considerable improvement in mechanical properties is attained. This case is all the more interesting because the metal is a cast iron with pearlite and ferrite, Brinell hardness 170 to 180, easy to machine, and produced with a cheap flux and normal working conditions in the cupola.

The photomicrograph, Fig. 5, shows the middle part of a malleable cast iron made by the European process. The texture is entirely pearlitic, the graphite being in nodules. It is this kind of texture that should be aimed at with a view to getting maximum strength. It seems doubtful whether it is possible to succeed without a heat treatment subsequent to casting. However, the researches of Piwowarski and Matsusiro Hamurami show that the dimensions and shape of the graphite particles of the melt can be considerably modified.

This contribution on high-tensile cast irons was written primarily with the object of giving the members of the "A. T. F. B." a summary of what has been done recently to improve the quality of cast iron.

Since the Committee of the Belgian Association have kindly suggested that the author should give a Paper on the same subject to the Institute of British Foundrymen he was glad to do so, although he realised that there will be very little that is new in it to numerous British foundrymen, who have already investigated these questions. Fresh results may have come to light in this country, where foundrymen are actively engaged on research work connected with the improvement in the strength properties of cast irons.

Specialisation Combines in Germany.

The formation of so-called specialisation and selling combines in Germany has proved an eminently practical method of cheapening production. The essential feature of such a combine is that two, five, ten and sometimes more works come to an agreement as to the mutual restriction of their manufacturing programmes in such a way that each kind or type of product is always manufactured at only one plant. Thus the programmes no longer overlap and the firms concerned no longer compete with one another. To each works are allotted those types of articles in which it has secured a larger turnover than its competitors hitherto, and each works abandons in favour of its previous competitors the production of these types in which the turnover was less. In this way the output figures of the types of product allotted to it are increased in each of the works in the combine, while the costs of production are correspondingly lessened. If, for example, ten works manufacture on an average 20 types and the total consumption of all the types is 200 articles per month, then each works has an average of 20 articles in 20 different types or one article of each type. But if the ten works distribute the 20 different types among themselves so that each works has only 2 instead of 20 types, then in the monthly turnover of 20 articles per works there are 10 articles to each type. The manufacture of a set of 10 articles per type, of course, works out considerably cheaper per article than that of a single article.

Simultaneously there is generally an agreement involving more or less close co-operation and mutual support in regard to marketing, so that selling costs may be reduced. This co-operation may be carried out in the most diverse ways. It may be limited to the mutual allocation of customers' inquiries; it may consist in the issue of common catalogues and other printed matter, the appointment of common representatives, or the preparation of common exhibitions of goods. It may, however, go so far as effecting all sales mutually through a central sales office. The method of co-operation in selling is primarily governed by the nature of the products, but also by the nature and organisation of the associated works. It is also dependent upon personal elements. In many cases the simpler forms of co-operation are adopted at first, and these gradually lead to a system of centralised sales if this should be found suitable. In any case co-operation in selling appears to be a necessary complement to specialisation in production, as thereby the selling costs are distributed over several products and a larger turnover. From co-operation in selling, whether in a centralised or a loose way, there will almost invariably result co-operation in other directions, particularly in regard to manufacture. Experiences are exchanged and prime costs are compared in order to discover how and where the manufacturing processes can be cheapened. Standards are adopted for parts which recur in different machines, or standards for the common working of the products of the combine in plants, and so on. In certain cases, moreover, a system of common purchasing has also been adopted.

These questions are exhaustively examined in the light of practical experience in a brochure entitled "Specialisation and Selling Combines in the Machinery Industry," published by the Association of German Machinery Works and edited by Schulz-Mehrin. This publication shows that the Association is desirous of contributing in a practical way to the promotion of industrial systematisation and, in particular, industrial specialisation. While the work is primarily intended for the machinery industry, it deals also with kindred branches, and the results and views communicated should prove valuable to many other branches of industry.

Parliamentary.

French and Belgian Steel Prices.

COMMANDER BELLAIRS asked the President of the Board of Trade if he could state the approximate advantage a French and Belgian manufacturer possessed through the depreciated exchange and rate of wages in quoting per ton of steel on the British market?

SIR PHILIP CUNLIFFE-LISTER said he was unable to estimate the effects of the depreciated exchanges and lower wages on the cost of producing steel in France and Belgium compared with that in this country. The following table, based on figures given in the IRON AND COAL TRADES REVIEW, showed the quotations for certain descriptions of steel f.o.b. French and Belgian ports, and delivered in the Birmingham district, together with corresponding quotations for home-produced steel :—

Current Quotations for Steel per English Ton.

	England and Wales. "Basis prices net; usual deliveries."	France. Export Prices f.o.b.	Belgium. Export Prices.	
			f.o.b.	Delivered Birmingham district.
		s. d. s. d.	s. d. s. d.	s. d. s. d.
Billets	125s. (soft)	84 3 to 85 3	84 3 to 85 3	105 0 to 106 6
Sheet bars	120s. to 122s. 6d.	89 0 „ 90 0	89 0 „ 90 0	109 3 „ 111 9
Joists	142s. 6d.	93 6 „ 95 6	93 6 „ 95 6	118 0 „ 119 6

Assistance for the Indian Steel Industry.

EARL WINTERTON has informed MR. THURTLE that the accounts showing the exact amount paid by the Indian Government in bounties to the Indian steel industry during the last financial year have not yet been received, but the amount for the preceding year was sixty lakhs (£450,000), and the latest estimate received for 1925-26 is 85 lakhs (£637,500).

Bricks.—Five hundred firebricks loosely stacked will take up 35 cub. ft. If closely stacked, the same number would cover approximately 27 cub. ft. For laying 500 bricks (red brick) it is quite sufficient for estimating purposes to reckon on 4¼ cub. ft. of sand and a good 1½ bushels of ordinary lime.

XUM

Re-Melting Pig-Iron in the Open-Hearth Process.*

By E. Herzog, Dr.Eng. (Hamborn).

The question as to whether the use of molten pig-iron in the scrap-pig-iron open-hearth process affords any appreciable advantages, particularly as regards shortening of the melting period, has long been the subject of controversy. That the decision has now been given in favour of charging liquid iron into the steel furnace is proved by the fact that an ever-increasing number of works are making arrangements for the direct supply of molten pig-iron from the blast furnaces to the open-hearth furnaces. It is still, however, an open question whether the advantages of using molten pig-iron are so great as to make it profitable for plants working without blast furnaces to pre-melt the pig-iron in a cupola. Only two cases are known to the author in which this method has actually been adopted, and in each case the reason for its adoption was that cupolas were available which were no longer required for the purpose for which they had originally been intended. Of these two works one was in America (the name is not given); a report of the results was published in 1921 in "The Iron Age." The other, which had recently completed arrangements for working in the same way was the "Rothe Erde" concern, near Aix-la-Chapelle, in Germany. At the American works the pre-melting process was in operation for 2½ months only, while the only blast furnace was under repairs, whereas at the German steelworks the process is still being worked, and will be retained so long as there is enough work to keep at the very least four furnaces going.

Here we have one of the most important limitations of the usefulness of the pre-melting process, namely, the necessity for the simultaneous operation of a certain number of open-hearth furnaces, to enable the pig-iron to be supplied at short intervals. The American works referred to above also worked with four open-hearth furnaces.

The kind of furnace for pre-melting the pig-iron seems to be undoubtedly the cupola. One factor in its favour is its low fuel consumption. Where the number of open-hearth furnaces is so small that the intervals in melting are too long for the cupola, the use of a pig-iron mixer between cupola and open-hearth furnace might be considered. The use of a pig-iron mixer, however, is limited by the fact that the tapping temperature in the cupola is lower than that in a normally working blast furnace, and that if the pre-melted pig-iron had first to pass through a mixer with a very small throughput it would lose so much of its heat that no sufficient shortening of the melting period would be attained.

Cupolas at Rothe Erde Works.

As regards the size and number of the cupolas, at the Rothe Erde Works the diameter of the outside shells of the cupolas is 4 m., while the inner diameter was reduced, at the level of the tuyeres from the original 3 m. to 1.6 m. for the pre-melting operation. The service time of the cupolas, which was formerly three days with intensive working and six days with normal working, was thereby increased to three or four weeks. The refractory lining of the iron shell up to and beyond the level of the tuyeres is made of adhesive sand. With such a long service time two cupolas will be found quite sufficient even in continuous working. When erecting a new plant it will be found advisable to increase the diameter of the lower part of the shell of the cupola so much that continuous working of three weeks may be counted upon. For this purpose and on the basis of the conditions existing at the Rothe Erde Works, the diameter of the cupola shell should allow of the lining being made at least 1 m. thick. As regards the inside diameter of the melting chamber at the start, the size of the blower and the volume of blast to be supplied, double the average amount of the pig-iron required should be taken as the maximum output capacity of the cupola.

As regards the quality of the pig-iron used in the pre-melting process it may be said that the quality may vary within very much wider limits than is possible in the case of open-hearth working with a cold pig-iron charge, as the cupola when amply supplied with limestone acts as a very good eliminator of silicon. This point is particularly emphasised in the above-mentioned American report. Indeed, one of the principal reasons for employing the pre-melting process in this case was that the open-hearth works in question had a large stock of pig-iron to work up in which low-silicon pig and pig containing as much as 6 per cent. of Si were mixed up indiscriminately, and that owing to the unequal quality and unsuitability of the pig-iron charge considerable difficulties had arisen in the open-hearth working. By pre-melting, with an ample addition of limestone, a much more uniform pig-iron was obtained, in which the silicon content was always below 1 per cent. The results obtained at the Rothe Erde Works were quite similar. At the latter works the amount of limestone added is now proportioned to suit the pig-iron used; this proportion must always be such that the test sample of the pre-melted pig-iron must show a fracture completely free from grey spots, no matter how high the percentages of silicon in the pig-iron may originally have been.

Elimination of Silicon in the Cupola.

At the Rothe Erde works the limestone consumption in the pre-melting of the iron for converter working was formerly 1.5 to 2 per cent., whereas in the pre-melting of grey pig-iron and particularly of cast-iron scrap for open-hearth working a consumption of 9 to 11 per cent. was reached. Thus the elimination of silicon as effected in the cupola represents a ready means of employing in the pre-melting operation also those grades of pig-iron which may be wholly unsuitable otherwise for open-hearth working. Care must be taken, however, that the percentage of sulphur in the pig-iron to be pre-melted in the cupola should not exceed a certain limit. This limit depends, of course, on various circumstances, particularly on the percentage of sulphur contained in the coke in the cupola, as well as on the kind of steel to be produced in the open-hearth furnace. If care is taken that the cast-iron scrap used does not include any material that has been in prolonged contact with flue gases and that the coke used for melting does not contain more than 1 per cent. of sulphur, the cupola will yield a pig-iron the sulphur content of which is generally not more than from 0.06 to 0.07 per cent. With such a pig-iron it is generally possible to keep the sulphur content of the steel below 0.05 per cent., a percentage which is unobjectionable in steel of ordinary commercial quality. The American report merely states that the sulphur content of the pre-melted pig-iron varied from 0.05 to 0.10 per cent.; apparently no difficulties had arisen under this head. According to the German author's experience difficulties are sure to arise when a maximum sulphur content of 0.04 per cent. or less is specified for the open-hearth steel. Experiments made with a view to de-sulphurising the pig-iron in the ladle with soda in accordance with the Walter process were successful *per se*, but it was not possible to keep down the desulphurising slag to a sufficient extent when charging the pig-iron into the open-hearth furnace. This difficulty, however, can be entirely overcome by using ladles with a bottom outlet.

Results at Rothe Erde Works.

A further point to be considered in connection with working is the question of loss of iron by ignition. With a large as well as with a small addition of limestone the silicic acid content of the cupola slag, according to the experience gained at the Rothe Erde Works, is always between 35 and 40 per cent., while the metal content (iron and manganese) diminishes in proportion as the lime content of the slag increases owing to a larger addition of limestone. With an ample addition of limestone the metal content is between 5 and 10 per cent.; in the case of a low-manganese pig-iron this percentage is still smaller. If the silicic acid

* From a Report of the Steelworks Committee of the German Iron and Steel Makers' Association.

were derived exclusively from the coke ash and the limestone as well as from the furnace lining, and if no reduction took place in the silicon content of the pig-iron, the loss of metal by ignition in the cupola would, in fact, represent in each case an additional loss which would considerably reduce the economy of the whole method. If, on the other hand, the ash content of the coke and the wear on the furnace lining were negligible and the silicic acid were formed principally by the abstraction of silicon from the pig-iron, then, as compared with steel production with a solid pig-iron charge in the open-hearth furnace, a diminution in the metal loss by ignition would have to be recorded, for in the open-hearth slag the proportion of metal oxides to the silicic acid is much higher than in the cupola slag. It will therefore depend on the content of silicon—and the extent of its reduction—in the pig-iron passing through the cupola, on the one hand, and on the amount and composition of the slag formed from the fuel ash and the refractory materials of the furnace lining, on the other hand, whether the pre-melting of the iron in the cupola, as compared with the working with a solid pig-iron charge in the steel furnace, involves a gain or loss as regards the total metal loss by ignition. Rough calculations show that upon the whole the conditions are probably such that in the pre-melting of steel-making iron in the cupola a metal loss must be reckoned with, where in the pre-melting of grey pig-iron or cast iron scrap a considerable reduction in such loss may be counted upon.

In considering the effects of using iron pre-melted in the cupola on steel production in the open-hearth furnace, the question next arises as to what extent we may expect the melting period to be shortened. Theoretically this curtailment must be the same as that obtained in working with the molten pig-iron from the blast furnace. In reality, however, it is not so, for the following reason: With regard to the action of the molten pig-iron it is by no means immaterial whether it is added, say, directly after the charging of the open-hearth furnace has been completed or very much later when the scrap is nearly all melted down. On the contrary, the saving in time is all the greater the more completely the scrap is melted at the moment the pig-iron is added; the most favourable effect is obtained when the scrap is melted until the last solid bit has disappeared. Such a method of working, however, is only possible if the pig-iron can be added punctually almost to the minute. Once the scrap has been melted down to that extent any delay in supplying the pig-iron would naturally be accompanied by evil consequences. It is, of course, not always possible even in the open-hearth pre-melting process to observe this condition absolutely; this applies particularly when the tapping periods of several open-hearth furnaces follow each other close together. On the other hand, the cupola is far superior to the blast furnace in this respect. According to the American report, owing to this circumstance a higher monthly output was obtained with the pre-melting operation in the open-hearth steelworks than had ever been possible before when the molten pig-iron was supplied from the blast furnace. This explains also the fact that many works using molten pig-iron from the blast furnace are able to record, in respect of the total result, only a relatively slight saving in time unless a pig-iron mixer is used.

Another difficulty that had an unfavourable influence on the results obtained at the Rothe Erde Works with pre-melted pig-iron added at the last possible moment to the open-hearth furnace, namely, the life of the stamped dolomite in the hearth which became increasingly unsatisfactory in proportion to the delay in adding the pig-iron. This difficulty, however, was finally overcome entirely when, on installing new hearths, stamped dolomite was replaced by brickwork of briquettes as used in the converter, in the manufacture of which calcined dolomite and calcined magnesite were used in equal proportions.

Loss of Iron by Ignition.

The figures given below with reference to the time saved at the Rothe Erde Works by charging molten pig-iron into the furnace were obtained at a time when the hearth difficulties had not yet been overcome, and therefore before the necessity of the longest possible delay in adding the pig-iron had been recognised. On the contrary, the pig-iron was added at a moment when a more or less deep bath of melted-down scrap had formed. At the same time, the average melting period of 6½ hours attained at the Rothe Erde Works with a solid pig-iron charge was generally shortened by one hour. The shorter the melting period with a solid pig-iron charge, the smaller will be the saving in time effected by using a molten charge. A melting period of from 5½ to 6 hours with a solid pig-iron charge will be shortened only by about 45 minutes, and, conversely, in the case of worn furnaces or of a poor-quality gas flame coal the saving in time increases in proportion to the length of the melting period, and in certain circumstances may even amount to more than one hour.

The economy of the pre-melting process is demonstrated most effectively by answering the following question:—In which case are steel-production costs lower: (*a*) In the case of an increase in the steel output from an existing open-hearth furnace plant due to pre-melting the pig-iron in the cupola, or (*b*) in the case of an increased output due to the installation of an additional open-hearth furnace to produce the same increase in production while working with a solid pig-iron charge as before?

On this basis the comparative economy of the pre-melting process was thoroughly investigated at the Rothe Erde Works. For the sake of simplification the depreciation costs for a newly installed additional open-hearth furnace with gas producers, on the one hand, and for a new cupola plant, on the other hand, were assumed to be of the same amount. At the American steelworks, according to the report referred to above, the total expenditure per ton of pre-melted pig-iron was entered on the balance sheet (in round figures) at $1 and the total receipts at $2.50, leaving a profit of $1.50, or 1½ times the pre-melting costs. As compared with this, at the Rothe Erde Works the total expenditure per ton of pre-melted pig-iron was 5.70 marks, 65 per cent. of this amount being for coke. On the savings side also the fuel was the principal item, in the form of the gas flame coal saved by using coke and including the coal used for the generation of steam. Other important savings were:—

(1) The lower consumption of pig-iron in the charge due to the shorter melting period. This saving in pig-iron ranged from 3 to 5 per cent. in accordance with the total amount of the pig-iron charge. The amount of profit accruing from this source, of course, depends largely on the position of the market, more particularly on the difference between the price of pig-iron and that of scrap.

(2) The saving in refractory materials is reflected in the fact that, according to the experience gained at the Rothe Erde Works, the life of an open-hearth furnace, expressed in working hours, remained the same with a solid and with a molten pig-iron charge, so that the brick consumption per ton of steel was reduced concurrently with the melting period. To these savings must be added the saving in wages at the open-hearth works. A further source of saving is afforded by the possibility, in the production of ordinary mild steel, of replacing the expensive pig-iron by cast-iron scrap, which, after the silicon has been eliminated in the cupola, is just as good as pig-iron. This last-named source of saving, which in certain circumstances may be considerable, has not been taken into consideration in the Rothe Erde balance sheet, as latterly basic pig only is being used there. The results obtained at the German steelworks compare as follow with those given in the American report:—The expenditure, as already stated, amounted to 5.70 mks. per ton of pig-iron, while the savings were 10.80 mks., leaving a gain of 5.10 mks., which works out at about a quarter of this amount for the ton of steel. This gain, let it be repeated, is not the entire gain obtained by the increase in output, but only shows the superiority of the pre-melting process as compared with an increase in output due to the addition of another open-hearth furnace to the plant. The stated gain is slightly lower than that obtained at the American works. It is, however, remarkable how closely the results recorded at both works coincide both in technical and economic respects.

XUM

Trade Talk.

HADFIELDS, LIMITED, Sheffield, who recently obtained a controlling interest in the motor works of Harper, Sons & Bean, Limited, have decided to call the new undertaking Bean Cars, Limited.

COL. SIR WILLIAM CHARLES WRIGHT and Sir John Cecil Davies, the chairman and vice-chairman respectively of Baldwins, Limited, have emphatically denied the rumour of a scheme for amalgamation with Richard Thomas & Company, Limited.

JOSEPH KAYE & SONS, LIMITED, Accommodation Road, Leeds are now engaged in supplying over 10,000 of their patent carriage door locks for the big railway groups. The latest order received by the firm is one of 2,000 locks for the Great Western Company.

CAMMELL, LAIRD & COMPANY, LIMITED, of Birkenhead, have received an order from the Isle of Man Steam Packet Company for a twin screw passenger steamer. Cammell, Laird & Company, Limited, also have an order for the construction of three fruit-carrying vessels for Elders & Fyffes.

THE METROPOLITAN VICKERS ELECTRICAL COMPANY, LIMITED, Trafford Park, Manchester, have an order from the Great Indian Peninsula Railway for 41 electric locomotives for the main line electrification from Bombay to Igatpuri and to Poona. The locomotives will each weigh 115 tons and will be rated at 2,600 horse-power.

THE MUNICIPALITY OF TOKIO has placed an order for 6 miles of 122-lbs. and 140-lbs. girder rails with the Mitsubishi Shoji Kaisha, and the order will probably go to the United States. The South Manchuria Railway Company have acquired about 70 miles of 65-lbs. rails, about 7,000 tons, from Okura & Company, New York, the business to go to an American firm.

THE BRIGHTSIDE FOUNDRY AND ENGINEERING COMPANY, LIMITED, have decided, for reasons of convenience and economy, to close their Wicker Works, Sheffield, and henceforth to carry on their business at the Newhall Road, Attercliffe, and Ecclesfield works, with the Attercliffe depôt as head office. The managing director of the firm, Mr. F. W. Firth, has stated that the closing down of the Wicker Works will enable the company to offer considerable extra facilities for production at the Newhall Road and Ecclesfield works, where large extensions and improvements are being made.

THE PRINCE OF WALES recently paid a visit to the works of Holman Bros., Limited, at Camborne. He drove straight into what is known as No. 1 works, where he was met by Messrs. J. Leonard Holman, A. Treve Holman, Percy M. Holman and Kenneth Holman, directors, and Mr. N. Curry, general works manager. The visit extended to one and a half hours, and concluded with a demonstration of rock-drill work with a portable compressor set, a piece of Cornish granite being bored to the depth of 17 inches in one minute. In the moulding shop the foreman, Mr. W. Harris, was introduced, and told the Royal visitor that he had been with the firm for 26 years. In No. 2 erecting shop the Prince spoke to Mr. Sydney Nettle, the foreman, who has been in the employ of the firm for 30 years, while in the smiths' shop he spoke to Mr. John Veale, the foreman, who is 70 years of age and has been working for the firm since 1868. At the No. 3 works, subsequently visited, his Royal Highness was received by Mr. B. Cock, the manager, his brother, Mr. W. Cock, publicity superintendent, who are the oldest members of the staff, having been there for 50 years, and Mr. J. Arthur.

Personal.

MR. I. PRETTY, the manager of the Wilden Ironworks, of Baldwins, Limited, has just completed 55 years with the firm. Commencing in a lower capacity, Mr. Pretty continued to advance until he was appointed manager 26 years ago, a position he holds to-day. He has been the recipient of a handsome presentation.

MR. J. HARDING BROWNE, chairman of Hamel & Horley, Limited, iron and steel merchants, etc., 106, Fenchurch Street, London, E.C.3, having retired, his interests in the company have been acquired by Blyth, Greene, Jourdain & Company, Limited, who will be represented on the board of directors by Mr. S. E. Roome and Mr. C. B. Ainslie.

Wills.

KENDRICK, J. A., a former chairman of Guest, Keen & Nettlefolds, Limited ... £101,775

WARLOW, F. A., a director of Edgar Allen & Company, Limited, Imperial Steel Works, Sheffield £38,458

BOYNTON, A. E., Ellington Road, Muswell Hill, of Boynton, Dowsett & Company, engineers, Goswell Road, E.C. £11,092

Contracts Open.

Cairo, July 20.—Supply and installation of centrifugal pumps and electric motors, for the Department of Municipalities of the Egyptian Minister of the Interior. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Reference A.X. 3230.)

Cairo, August 1.—Installation of electric power station equipment for the production of three-phase alternating current, at 3,300 volts, 50 cycles, per second, for the Egyptian Ministry of the Interior. The Department of Overseas Trade (Room 52), 35, Old Queen Street, Westminster, London, S.W.1

Dublin, June 28.—(1) One steam turbo boiler feed pump; (2) three air filters for alternators; and (4) steam and water meters; for the Commissioners. The City Electrical Engineer, Electricity Works, Fleet Street, Dublin. (Fee, £2 2s., returnable.)

London, S.E.1, July 1.—The Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1, requires oil-engine driven power plant. Tender forms obtainable from above.

London, S.E.1, July 6-13.—(1) Locomotive engines and tenders; (2) steel spring for laminated and spiral springs; for the Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Tenders due July 6 for (1) and July 13 for (2).

Meltham, Yorks, July 1.—One Ideal B heating apparatus boiler, complete in six sections, and the connecting of same to the existing heating apparatus. Mr. W. R. Carter, Birchfield, Meltham.

Wellington, N.Z., August 24.—Synchronous condensers (section 18, Waikaremoana), for the Public Works Department, New Zealand. The Department of Overseas Trade (Room 52), 35, Old Queen Street, London, S.W.1. (Reference No. B.X. 2608.)

Company Reports.

Howard & Bullough, Limited.—Quarterly dividend, 2½ per cent., less tax, on ordinary.

Edgar Allen & Company, Limited.—Dividend on ordinary shares, 5 per cent. for year, tax free.

Broughton Copper Company, Limited.—Final dividend, 10 per cent., less tax, making 15 per cent. for year.

Galloways, Limited.—Interest, 3 per cent. (actual), less tax, on debenture stock; no payment on preference shares.

Pather Iron and Steel Company, Limited.—No dividend; carried forward, £175, after transferring £3,000 from special reserve.

United Strip and Bar Mills, Limited.—Profit for year, crediting income-tax recovered, £2,860; debit balance brought forward reduced from £30,110 to £27,250.

Brooks & Doxey (1920), Limited.—Trading profit, £11,786; income tax, £3,500; depreciation, £26,000; net loss, £17,713; debit forward, £67,447; debit carry forward, £85,161.

Consett Iron Company, Limited.—Loss for year, £136,227; interest on debenture stock, £150,000; total, £286,227; brought forward, £21,857; standing to debit of profit and loss account, £264,370; write off special expenditure, £3,004.

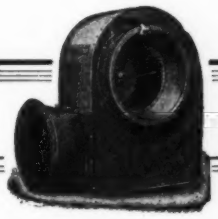
Ransomes, Sims & Jefferies, Limited.—Profit, £87,969; brought forward, £56,630; dividend on preference shares to December 31, 1925, £11,000; special reserve, £25,000; reserve account, £25,000; dividend on ordinary shares, 5 per cent. per annum, subject to tax, £25,000; carried forward, £58,599.

Platt Brothers & Company, Limited.—Net profit, £253,381; final dividend, 7½ per cent., less tax, making 10 per cent. for year; written off goodwill, £560,000; transfer from taxes reserve fund, £320,000; transferred from profit and loss account, £2,456; re-valuation of certain of fixed assets, £237,544.

Brush Electrical Engineering Company, Limited.—Net profit, £62,196; brought forward, £76,190; reserve, £5,544; further 4 per cent. interest on Prior Lien participating second debenture stock, £2,044; dividend, 10 per cent. for year, £45,856; suspense account in connection with proposed co-partnership scheme, £8,751.

Meters, Limited.—Net loss for year, £7,966; transferred from reserve, £15,000; brought forward, £7,488; total, £22,488; deducting loss on year and interim dividends paid, £14,051; amount available, £8,437; final dividends for year, 2¼ per cent. (actual) upon preference, and 3 per cent. (actual) upon ordinary (making for year 5½ per cent. and 5 per cent. respectively); carried forward, £752.

THE DEIGHTON IRON AND STEEL WORKS, Tredegar, owned by Whitehead & Company, Limited, will recommence this week.



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IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—Conditions in the Cleveland iron trade are rapidly progressing to the stage of complete stagnation, with, so far, little sign of an early termination of the unhappy struggle now raging in the coalfield. In the circumstances now prevailing, business of buying and selling is practically impossible, for most of the makers are already oversold, and the furnaces on Tees-side, with an almost solitary exception, are idle, the small output in this instance being absorbed in the adjacent works. There have been a few attempts to do forward business, but sellers are not inclined to discuss it seriously, having regard to the extreme uncertainty as to what the post-strike position will be. Prices of foundry iron have steadily advanced since the strike began, but whether it will be possible to maintain the levels now reached when normal conditions are resumed remains to be seen. Consumers requiring No. 3 G.M.B. have now to pay a minimum of 80s. per ton for it, while No. 1 is obtainable at 82s. 6d., No. 4 foundry 79s., and No. 4 forge 78s. 6d. per ton.

Hematite Pig-Iron.—The hematite position on Tees-side is quite unchanged. Only a few odd parcels are changing hands, though since the strike began the call upon stocks in the aggregate has been pretty considerable. Still, there are fair accumulations, and East Coast mixed numbers can be done at 78s. 6d. per ton, which is about the figure of a week ago. No. 1 is quoted at 79s. per ton. On the North-West coast, meantime, prices are maintained at their old level, Bessemer mixed numbers being quoted at £4 2s. 6d. c.i.f. Welsh ports, £4 5s. 6d. to £4 7s. 6d. per ton delivered at Glasgow, £4 8s. to £4 10s. per ton delivered at Sheffield, £4 15s. to £4 16s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—In this important centre of the industry foundrymen are making strenuous efforts to keep work going, but increasing difficulty is experienced in overcoming the problem of a shortage of fuel. With regard to the market for foundry pig, some silky Northampton iron is offered at 75s. and up, and what Derbyshire quality is available is at about 75s. to 80s. All these prices are at the furnaces. There is still a little Cleveland 1 and 3 grades offered, which is being taken by consumers in this district, the quotation, delivered station or siding in this locality, being about 91s. 6d. per ton for No. 3, with 3s. per ton extra for No. 1 grade.

THE MIDLANDS.—There are only very limited stocks of foundry pig now at the Northants, Derbyshire, and North Staffordshire furnaces. No No. 3 or 1 irons are to be obtained, and, of course, none of the furnaces is in blast. Prices have, consequently, remained firm up to some extent, quotations ruling nominal at around 85s. per ton for Derbyshire No. 3 foundry pig, and about 97s. 6d. for Scottish, delivered Manchester or equal distance.

SCOTLAND.—With certain brands of Scotch iron unobtainable, and others getting scarce, prices are hardening, and No. 3 is generally quoted at 80s. per ton, f.o.t. furnaces. This is 5s. fully from the bottom, but even then it is much cheaper than Middlesbrough iron, for which the current quotation at Grangemouth is 81s. 6d. per ton.

Finished Iron.

In the obviously difficult situation now confronting the manufacturing departments, business is naturally more and more restricted in volume. Most of the mills have been able to dispose of the stocks they held, and very few are anxious to quote prices at this juncture for delivery after the strike. So far as may be gleaned, however, there is no change at present, but what will be the ultimate figures is a matter of conjecture. The stocks are being disposed of round about £11 5s. for crown quality, and £9 15s. to £10 for second grades. There has been a fair amount of business placed abroad for nut and bolt iron, for which the price seems to be somewhat stiffer, although it is still possible to purchase this iron at a shade under £6 delivered works here, for July/August shipment.

Steel.

Steel manufacturers everywhere are gradually coming to the end of their resources, and many furnaces have already closed down. In fact, in Wales all the makers of billets and sheet and tinplate bars are idle, and those tinplate and sheet rollers who are able to continue will be compelled to draw the whole of their requirements of semis from abroad. These are being very freely offered for delivery after July, and some contracts are being made in the hope that by the time the material arrives it will be possible to use it. The Continental price appears to have a tendency to stiffen. The tinplate market is very quiet, and very little business has been done owing to the small production. There is a strong demand for stock plates, which are commanding much higher prices.

Scrap.

The only "live" feature in the scrap market is heavy cast-iron scrap, which is now in some little demand owing to the scarcity and high price of pig-iron. At Middlesbrough, machinery qualities are readily saleable at 67s. 6d., and ordinary at about 65s. per ton, delivered at works. Similar conditions may be found in the Scottish markets, where of late the inquiry from foundries for cast scrap has been rather good, with some moderate lots changing hands. This is attributed to the firming of the price of pig-iron, which for some brands is now rather scarce. Heavy machinery cast-iron scrap is being quoted up to 73s. 6d. to 75s. per ton, and for good, clean, heavy ordinary cast 70s. to 71s. 3d. per ton. It is doubtful whether the nominal prices at present will be maintained when works resume, as stocks there are pretty high.

Metals.

Copper.—After a somewhat prolonged period of comparative inactivity, the market for standard copper has evidenced of late symptoms of reviving vitality, with a growing disposition to speculative interest, resulting in values distinctly tending to slightly higher levels than has recently been noted. The principal stimulating factor has been apparently the demand from domestic users in America, and the market has enjoyed quite a firm undertone at the advance. The market for fine copper has also been more active, and quotations for electrolytic and wire bars have advanced.

Official closing prices of standard copper have been as under :—

Cash : Thursday, £56 2s. 6d. ; Friday, £57 ; Monday, £57 2s. 6d. ; Tuesday, £57 ; Wednesday, £56 2s. 6d.

Three Months : Thursday, £58 ; Friday, £57 15s. ; Monday, £58 ; Tuesday, £57 17s. 6d. ; Wednesday, £57 15s.

Tin.—Increasing confidence is also a marked feature in this section of the market, and values have registered additional strength, with an advance of about £7 at the end of the week. It seems that the opinion prevailed in certain quarters that the recent depression had partaken of a rather artificial character, and, in spite of the large increase in the visible supply for May, the market now stands at a level even higher than before the unsatisfactory statistics were issued. Evidently the latter had been discounted, and there is no doubt that the more hopeful reports about industrial activity, in spite of the recent rather reactionary developments, have tended to encourage fresh enterprise on the part of the chief bull interests.

Official closing prices of standard tin have been as follow :—

Cash : Thursday, £271 15s. ; Friday, £271 10s. ; Monday, £270 15s. ; Tuesday, £271 ; Wednesday, £273 15s.

Three Months : Thursday, £271 5s. ; Friday, £271 ; Monday, £270 5s. ; Tuesday, £270 10s. ; Wednesday, £273 5s.

Spelter.—Dealings in this metal during the week have been on a satisfactory scale, following a better demand on the Continent and owing to the establishment of higher prices in America, where, it is understood, that smelters are curtailing their operations. Since the end of May there has been a continuous rise in values, despite the disastrous industrial conditions in this country, and the movement just lately has been particularly marked.

The following are the week's prices :—

Ordinary : Thursday, £33 15s. ; Friday, £33 8s. 9d. ; Monday, £33 2s. 6d. ; Tuesday, £33 1s. 3d. ; Wednesday, £33 8s. 9d.

Lead.—The market for prompt soft foreign pig has been firm, and values have steadily advanced. The feature in the metal has been the revival of German buying, which, however, appears to have run its course, and at one time the market reacted from the best. There is still, however, a very large surplus hanging over the market, which is estimated at upwards of 20,000 tons.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £31 1s. 3d. ; Friday, £30 8s. 9d. ; Monday, £30 5s. ; Tuesday, £29 13s. 9d. ; Wednesday, £30 1s. 3d.

"GLUTRIN" STANDS ALONE

THE WORLD'S FINEST CORE BINDER

After twenty years Foundry Service
it is still going strong.

Economise in production by using

"GLUTRIN"

and thus cutting out wasters.

"GLUTRIN" IS WORTH A TRIAL
IT MEANS YOUR ORDER TO US.

WHY NOT?

Full particulars from the following stockists:

MIDDLESBROUGH:
Messrs. Thomas Wilkinson & Co., Ltd., Stockton Street, Middlesbrough.

LONDON:
Messrs. The Blackfriars Foundry Requisite Co., Ltd., 34/35, Norfolk Street, London, W.C.2.

GLASGOW:
Messrs. Albert Smith & Co., Foundry Engineers, etc., 60, St. Enoch Square, Glasgow.

FOUNDRY BRUSHES OF QUALITY—USED ALL OVER THE WORLD

SIEVES

RIDDLES

BEST MATERIAL—WELL FILLED—QUICK DELIVERY, AND AT THE RIGHT PRICES.

BETHEL RHODES & SONS, WIREWORKS, NORTH ST., **KEIGHLEY, YORKS.** ESTABLISHED 1835. SEND FOR LIST.

PIG IRON?

ARE YOU EXPERIENCING—OR DO YOU FORESEE—ANY SHORTAGE?

WE CAN SUPPLY AND KEEP YOU SUPPLIED WITH:—

(1) **HIGH PHOSPHORUS FOUNDRY**—Similar to Cleveland, or other Middlesbro' and Midland Qualities **for General Foundry Work.**

(2) **ROYAL DUTCH LOW PHOSPHORUS FOUNDRY**—To replace Scotch Brands. **A High-Class Iron for Better Castings.**

(3) **SPECIAL CYLINDER IRON "LOWCAR"**—Unique. Total Carbon 2.40% Max. Sulphur up to 0.06% Max.

FAVOURABLE PRICES—RELIABLE QUALITY

EARLY SHIPMENT

Enquiries to:—

BESSLER, WAECHTER & CO., LTD.

SALISBURY HOUSE, FINSBURY CIRCUS, E.C.2.

XUM

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash ..	56	2	6
Three months ..	57	15	0
Electrolytic	64	15	0
Tough	61	15	0
Best selected ..	62	5	0
Sheets	90	0	0
India	74	0	0
Wire bars	65	10	0
Do. June–July ..	65	7	6
Do. July–August	65	7	6
Ingot bars	65	5	0
H.C. wire rods ..	69	15	0
Off. av. cash, May	56	11	1½
Do., 3 mths. May	57	8	10½
Do., Sttlmnt, May	56	10	4½
Do., Electro, May	64	10	10½
Do., B.S., May ..	60	14	4½
Aver. spot price copper, May ..	56	10	4½
Do., wire bars, May	64	15	6
Solid drawn tubes			12¾d.
Brazed tubes ..			12¾d.
Wire			9½d.

BRASS.

Solid drawn tubes ..	11¾d.
Brazed tubes	13¾d.
Rods, drawn	10⅞d.
Rods, extd. or rlld. ..	7½d.
Sheets to 10 w.g ..	10½d.
Wire	9⅞d.
Rolled metal	9½d.
Yellow metal rods ..	7½d.
Do. 4 × 4 Squares	8d.
Do. 4 × 3 Sheets ..	8½d.

TIN.

	£	s.	d.
Standard cash ..	273	15	0
Three months ..	273	5	0
English	272	0	0
Bars	271	0	0
Straits	280	10	0
Australian	274	0	0
Eastern	277	0	0
Banca	274	5	0
Off.aver. cash, May	270	5	0¾
Do., 3 mths., May	266	14	5½
Do., Sttlmt. May	270	4	9
Aver. spot., May	270	4	9

SPELTER.

	£	s.	d.
Ordinary	33	8	9
Remelted	32	15	0
Hard	28	5	0
Electro 99.9 ..	36	7	6
English	33	10	0
India	31	0	0
Zinc dust	42	0	0
Zinc sales	14	10	0
Off. aver., May ..	32	4	6
Aver., spot, May	32	0	9

LEAD.

	£	s.	d.
Soft foreign ppt.	30	1	3
English	31	10	0
Off. average, May	28	9	8⅝
Average spot, May	28	5	0

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	41	0	0
Do. V.M. ex whf.	38	0	0
Rods	44	0	0
Boiler plates ..	38	10	0
Battery plates ..	38	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	84	10	0
Chinese	59	0	0
Crude	40	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver ..	15	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon	
25%	£9 0 0
45/50%	£11 7 6
75%	£19 15 0
Ferro-vanadium—	
35/40% 14/9 to 15/6 lb. va.	
Ferro-molybdenum—	
70/75% c. free 6/– to 6/3 lb.	
Ferro-titanium—	
23/25% carbonless 11½d. lb.	
Ferro-phosphorus, 20/25%, £17 0 0	
Ferro-tungsten—	
80/85%, c.fr. .. 1/6 lb.	
Tungsten metal powder—	
98/99% .. 1/11 lb.	
Ferro-chrome—	
2/4% car. .. £33 10 0	
4/6% car. .. £22 0 0	
6/8% car. .. £21 15 0	
8/10% car. .. £20 12 6	
Ferro-chrome—	
Max. 2% car. £37 2 6	
Max. 1% car. £43 10 0	
Max. 0.70% car. £54 10 0	
70%, carbonless 1/5½ lb.	
Nickel—99%, cubes or pellets .. £170	
Cobalt metal—98/99% 10/– lb.	
Aluminium 98/99% £118	
Metallic Chromium—	
96/98% .. 3/3 lb.	
Ferro-manganese (net)—	
76/80%, loose £15 0 0	
76/80%, packed £16 0 0	
76/80%, export £14 5 0	
Metallic manganese—	
94/96%, carbonless 2/– lb.	
Per ton unless otherwise stated.	

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten ..	s. d. 2 6
Finished bars, 18% tungsten ..	3 0
Per lb. net, d/d buyers' works.	
Extras—	
Rounds and squares 3 in. and over ..	4d. lb.
Rounds and squares under ½ in. to ¼ in.	3d. lb.
Do. under ¼in. to ⅛ in.	1/– lb.
Flats, ½in. × ⅛in. to under 1 in. × ⅛ in.	3d. lb.
Do. under ½in. × ⅛in.	1/– lb
Bevels of approved sizes and sections	6d. lb.
Bars cut to length	10% extra
Scrap from high-speed tool steel—	
Scrap pieces	3d.
Turnings and swarf	1d.
Per lb. net, d/d steel makers' works.	

SCRAP.

	£	s.	d.
South Wales—£ s. d.			
Hvy. steel	3	7	6
Bundled steel & shrngs. 3 3 0 to	3	6	0
Mixed iron & steel 3 0 0 to	3	2	6
Heavy cast iron	3	5	0
Good machinery for foundries ..	3	5	0
Cleveland—			
Heavy steel ..	3	1	0
Steel turnings ..	2	6	0
Cast iron borings	2	5	0
Heavy forge ..	4	2	6
Bushelled scrap	3	10	0
Cast-iron scrap	3	7	6
Lancashire—			
Cast-iron scrap 3 2 6 to	3	10	0
Hvy. wrought ..	3	2	6
Steel turnings ..	2	2	0
London — Merchants' buying prices delivered yard.			
Copper (clean)..	48	0	0
Brass (clean) ..	38	0	0
Lead (less usual draft)	27	0	0
Tea lead ..	22	10	0
Zinc	22	10	0
New aluminium cuttings ..	80	0	0
Braziery copper	44	0	0
Gunmetal ..	45	0	0
Hollow pewter	180	0	0
Shaped black pewter ..	132	0	0

PIG-IRON.

(*f.o.t. unless otherwise stated*).

N.E. Coast—	
Foundry No. 1 ..	82/6
Foundry No. 3 ..	80/–
Foundry No. 4 ..	79/–
Forge No. 4	78/6
Hematite No. 1 ..	79/–
Hematite M/Nos. ..	78/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	86/6
„ d/d Birm.	95/9
Midlands—	
Staffs common* ..	—
„ No. 4 forge ..	—
„ No. 3 foundry	—
Shrops. basic	70/–
„ Cold blast, ord.*	185/–
„ „ roll iron* ..	190/–
* d/d Birmingham.	
Northants forge	—
„ fdry No. 3 ..	78/9
Derbyshire forge ..	—
„ fdry. No. 3 ..	78/9
„ basic	—
Scotland—	
Foundry No. 1 ..	85/–
„ No. 3 ..	80/–
Hem. M/Nos.	77/–
Sheffield (d/d district)—	
Derby forge	—
„ fdry. No. 3 ..	—
Lincs. forge	—
„ fdry. No. 3 ..	—
E.C. hematite	90/–
W.C. hematite ..	89/–
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3.. ..	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	—
„ fdry. No. 3 ..	87/6
Northants foundry No. 3	—
Dalzell, No. 3	110/–
Summerlee, No. 3 ..	97/6
Glengarnock, No. 3 ..	97/6
Gartsherrie, No. 3 ..	97/6
Monkland No. 3	97/6
Coltness, No. 3	97/6
Shotts, No. 3	97/6

FINISHED IRON & STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.	£	s.	d.
Bars(cr.)	11	5	0 to 12	0	0	
Angles			11	10	0	
Tees to 3 united ins.			12	0	0	
Nut and bolt	10	5	0 to 10	7	6	
Hoops	14	0	0 to 15	0	0	
Marked bars (Staffs.) f.o.t. ..			14	0	0	
Gas strip			12	10	0	
Bolts and nuts .. ¾ in. × 4 in. ..			15	5	0	
Steel—						
Ship plates	7	12	6 to 7	17	6	
Boiler plts. ..			11	5	0	
Chequer plts. ..			9	15	0	
Angles			7	2	6	
Tees			8	2	6	
Joists			7	2	6	
Rounds and Squares 3 in. to 5½ ins. ..			8	0	0	
Rounds under 3 in. to ⅜ in.			7	15	0	
Flats, over 5 in. wide and up ..			8	10	0	
Flats, 5in. to 1¼in.			7	10	0	
Rails, heavy ..			8	0	0	
Fishplates			12	0	0	
Hoops (Staffs.) ..			10	10	0	
Black sheets, 24g.			10	17	6	
Galv. cor. sheets, 24g.			16	0	0	
Galv. fencing wire 8g. plain			13	0	0	
Billets, soft ..			6	5	0	
Billets, hard ..			8	2	6	
Sheet bars	6	0	0 to 6	2	6	
Tin bars d/d	6	2	6 to 6	5	0	

PHOSPHOR BRONZE.

	Per lb.	basis.
Strip	1	3
Sheet to w.g.	1	3½
Wire	1	3½
Rods	1	3
Tubes	1	8
Castings	1	2

Delivery 3 cwt. free
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb. basis.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks ..	9d. to 1/5½
Ingots rolled to spoon size ..	1/– to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON & STEEL.

At Pittsburgh unless otherwise stated.	Dols.
No. 2X foundry, Phila.	22.76
No. 2 foundry, Valley	19.76
No. 2 foundry, Birm.	21.00
Basic	19.76
Bessemer	20.76
Malleable	19.76
Grey forge	19.26
Ferro-mang. 80% d/d	88.00
Bess. rails, h'y, at mill	43.00
O.-h. rails, h'y at mill	43.00
Bess billets	35.00
O.-h. billets	35.00
O.-h. sheet bars ..	36.00
Wire rods	45.00
	Cents.
Iron bars, Phila. ..	2.22
Steel bars	2.00
Tank plates	1.85
Beams, etc.	1.90
Skelp, grooved steel ..	1.90
Skelp, sheared steel ..	1.90
Steel hoops	2.50
Sheets, black, No. 28..	3.10
Sheets, galv., No. 28 ..	4.30
Sheets, blue an'l'd, 9 & 10	2.35
Wire nails	2.65
Plain wire	2.50
Barbed wire, galv. ..	3.35
Tinplate, 100 lb. box	$5.50

COKE (at ovens).

Welsh foundry ..	32/6 to 40/–
„ furnace ..	20/– to 25/–
Durham & North.	
„ foundry	30/– to 33/–
„ furnace	14/– to 14/6
Other Districts, foundry	30/– to 33/–
„ „ furnace (basis)	11/9

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. Cokes,	20×14, box	21/6
„	28×20, „	43/–
„	20×10, „	32/–
„	18¾×14, „	22/3
C.W.	20×14, „	20/3
„	28×20, „	40/6
„	20×10, „	26/6
„	18¾×14, „	20/6

Terneplates 28×20, 37/– per box basis f.o.b.

SWEDISH IRON.

Bars, hammered	£18/10 to £19/0
Rolled Ord.	£15/15/0 to £16/5/0
Nail rods	£16 5 0 to £16 15 0
Keg. steel nom.	£33 to £35
Faggot steel nom.	£22 to £25
Blooms, according to quality	£9 to £12
Pig-iron	£6 5 0 to £7 0 0

all f.o.b. Gothenburg.

TUBES AND FITTINGS.
Up to and incl. 6 in.

	Tubes	*Fittings*
Gas	60%	50%
Water	55%	45%
Steam	50%	40%

W.I. 10% extra.

DAILY FLUCTUATIONS.

Standard Copper (Cash).

	£	s.	d.	
June 17	57	2	6	dec. 5/-
,, 18	57	0	0	,, 2/6
,, 21	57	2	6	inc. 2/6
,, 22	57	0	0	dec. 2/6
,, 23	56	2	6	,, 17/6

Electrolytic Copper.

	£	s.	d.	
June 17	65	0	0	No change
,, 18	65	0	0	,, ,,
,, 21	65	0	0	,, ,,
,, 22	65	0	0	,, ,,
,, 23	64	15	0	dec. 5/-

Standard Tin (Cash).

	£	s.	d.	
June 17	271	15	0	inc. 50/-
,, 18	271	10	0	dec. 5/-
,, 21	270	15	0	,, 15/-
,, 22	271	0	0	inc. 5/-
,, 23	273	15	0	,, 55/-

Tin (English ingots).

	£	s.	d.	
June 17	269	10	0	inc 45/-
,, 18	269	5	0	dec. 5/-
,, 21	268	15	0	dec. 10/-
,, 22	269	0	0	inc. 5/-
,, 23	272	0	0	,, 60/-

Zinc Sheets (English).

	£	s.	d.	
June 17	41	0	0	No change
,, 18	41	0	0	,, ,,
,, 21	41	0	0	,, ,,
,, 22	41	0	0	,, ,,
,, 23	41	0	0	,, ,,

Spelter (ordinary).

	£	s.	d.	
June 17	33	15	0	No change
,, 18	33	8	9	dec. 6/3
,, 21	33	2	6	,, 6/3
,, 22	33	1	3	,, 1/3
,, 23	33	8	9	inc. 7/6

Lead (English).

	£	s.	d.	
June 17	32	5	0	No change
,, 18	32	0	0	dec. 5/-
,, 21	31	15	0	,, 5/-
,, 22	31	5	0	,, 10/-
,, 23	31	10	0	inc. 5/-

Exports of Iron Castings in May and the five months 1926, compared with May and the five months 1925.

	May, 1925	May, 1926	Five months, 1925	Five months, 1926	May, 1925	May, 1926	Five months, 1925	Five months, 1926
BUILDERS' CASTINGS—	Tons.	Tons.	Tons.	Tons.	£	£	£	£
Stoves, Grates, etc., Cisterns, Baths, etc., and cooking and washing boilers—								
To Argentine Republic	177	140	689	603	6,047	6,357	23,981	24,045
,, British South Africa	281	343	1,508	2,061	10,505	11,885	54,473	68,792
,, ,, East Indies	193	140	761	774	8,117	6,180	37,074	34,734
,, Australia	58	33	358	419	2,844	1,999	19,312	23,797
,, New Zealand	199	157	1,162	1,080	9,198	7,273	54,986	51,682
,, Other countries	722	623	3,220	3,224	36,658	28,257	163,429	154,548
Total	1,630	1,436	7,698	8,161	73,369	61,951	353,255	357,598
PIPES AND FITTINGS—CAST—								
To Argentine Republic	1,221	721	4,902	4,003	15,793	9,070	64,410	51,715
,, British South Africa	952	739	3,290	3,218	13,329	9,452	45,157	45,562
,, ,, India	922	358	4,972	4,622	12,729	5,550	70,729	56,772
,, Straits Settlements & Malay States	298	122	2,764	9,213	4,816	1,664	32,385	75,399
,, Ceylon	66	74	566	1,174	798	861	7,387	12,927
,, Australia	337	328	1,457	2,368	4,871	3,743	21,811	30,001
,, Other countries	4,170	3,845	23,375	23,191	65,987	52,045	347,083	312,258
Total	7,966	6,187	41,326	47,789	118,323	82,385	588,962	584,634
HOLLOW-WARE—								
Cast, not Enamelled, and Cast, Tinned	566	433	3,632	2,963	20,380	15,876	117,613	101,845
,, Enamelled	80	99	445	405	8,290	8,194	43,138	41,019
CASTINGS, in the rough—								
Iron	86	107	508	704	3,660	3,347	20,594	20,384
Steel	49	42	212	383	2,235	1,284	8,267	10,673

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

18, BENNETTS HILL, BIRMINGHAM.

18, BENNETTS HILL, BIRMINGHAM.
11, OLD HALL STREET, LIVERPOOL.
EXCHANGE BLDGS., PORT TALBOT.
FOWLERS BUILDINGS, BOMBAY.
CLIVE STREET, CALCUTTA.
ANGAPPA NAICK STREET, MADRAS.

REGISTERED TRADE MARK
LUMPEX

1, HONG KONG ROAD, SHANGHAI.
OCEAN BUILDING, SINGAPORE.
JAVA STREET, KUALA LUMPUR
5, SHAFFRAZ ROAD, RANGOON.
COX'S BUILDINGS, KARACHI.
P.O. BOX 1580, CAIRO.

PIG IRON

SCOTCH, MIDDLESBRO', HEMATITE, BASIC, SPECIALS, &c.,

NON-FERROUS METALS

COPPER, TIN. LEAD, SPELTER, ANTIMONY, CHROME ORE

WILLIAM JACKS & COMPANY,

19, ST. VINCENT PLACE, GLASGOW.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 7 words per line. Minimum charge for one insertion 3/-.

PERSONAL.

A. V. GODDARD, SHEFFIELD.—If you are the "sport" you claimed to be at the Exhibition you will send your address to TOM GRAY, 119, High Holborn, London.

SITUATIONS VACANT AND WANTED.

POSITION wanted as Foundry Manager, or Foreman, by a first-class Foundryman of wide experience and practical knowledge; thoroughly up to date and familiar with every detail connected with foundry work.—BOX 742, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

GENTLEMAN, with connection among Foundries on Tyneside and North of England, seeks position as Representative for Foundry Facings and Requisites or good Agencies.—Write, Box 744, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

IRON AND BRASS FOUNDERS.—Successful Commercial Manager, Metallurgist, desires change; first-class experience soft grey and malleable, eight years' non-ferrous; inside and outside man; sound commercial training; expert costs.—Box 724, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

MANAGER (Dutchman) of one of the representative offices at Rotterdam of a big German blast-furnace and foundry concern feels obliged to vacate his Managership on account of the recent establishment of the United Steelworks in Germany; expert in ores and coal, conversant with general chartering (both sea and river transport), and also capable of managing a regular line.—Letters under "R. A. Z." at Nijgh & van Ditmar's Adv. Agency, Rotterdam, Holland.

WORKS MANAGER or FOREMAN required by large firm; must have had considerable experience in up-to-date manufacture of Graphite Crucibles, etc.; good salary will be paid to a fully competent man.—Apply, Box 740, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EX-OFFICERS AND OTHER RANKS.

The Proprietors of the FOUNDRY TRADE JOURNAL have placed this space at the disposal of the British Legion, Officers' Association, Employment Bureau, 3-4, Clement's Inn, Strand, London, W.C.2. (telephone: Holborn 5769), to whom all replies should be addressed, quoting number of advertisement, date on which it appeared, and the name of this paper.

EX-OFFICER, with general commercial and engineering training, desires Secretarial work; book-keeping and staff control; energetic; thoroughly trustworthy and reliable; open to accept any position at a moderate salary at home or abroad. (Dis. 48)

ELECTRICAL AND MECHANICAL ENGINEER, M.I.E.E., late Major, Royal Engineers; all-round experience, executive and practical, A.C. and D.C., steam and internal-combustion engines, turbines, boilers, wiring, overhead and underground distribution, reports, estimating, handling of men, typing, shorthand, accounts. (614)

MECHANICAL ENGINEER, 48, married, Public School, regular apprentice marine engineering, four years' draughtsman general engineers, 10 years' superintending engineer, rubber companies' experience, designing and erecting factories, etc., office work, special knowledge vacuum drying plant, rubber and vegetable products, requires post, Factory Engineer or Adviser and Consultant *re* machinery, etc., required for East. (1333)

AGENCIES.

MANAGER of large American Cast Iron Sanitary Ware Factory intends locating in Great Britain, and is desirous of getting in touch with a firm who can utilise his services; thoroughly conversant with all modern processes for mass production.—Box 758, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

PROPERTY.

OLD-ESTABLISHED Iron and Brass Foundry (outer London district) for Sale as a going concern; Company's output approximately £6,000 per annum, but capable of improvement; favourable situation and excellent railway facilities.—Apply in the first instance to CHAS. W. ROOKE & COMPANY, Chartered Accountants, 2, Norfolk Street, Strand, W.C.2.

BRASS FOUNDRY FOR SALE; established 9 years; brick and slated building, 2 pit furnaces, etc.; contract and orders on hand; rent £26 per annum; stock £15; price £200 A.A.—DAWSONS (established 30 years), 27, Station Road, West Croydon.

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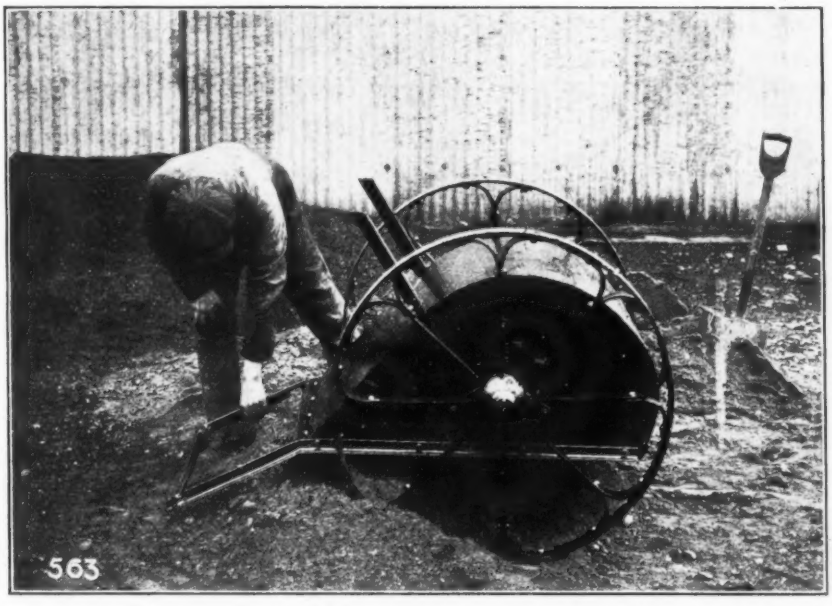

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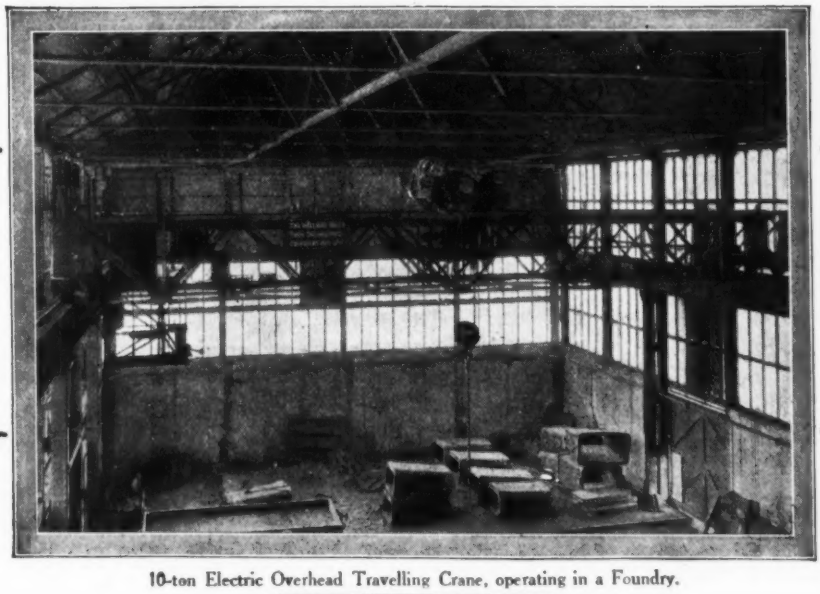

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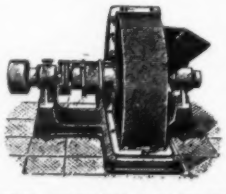

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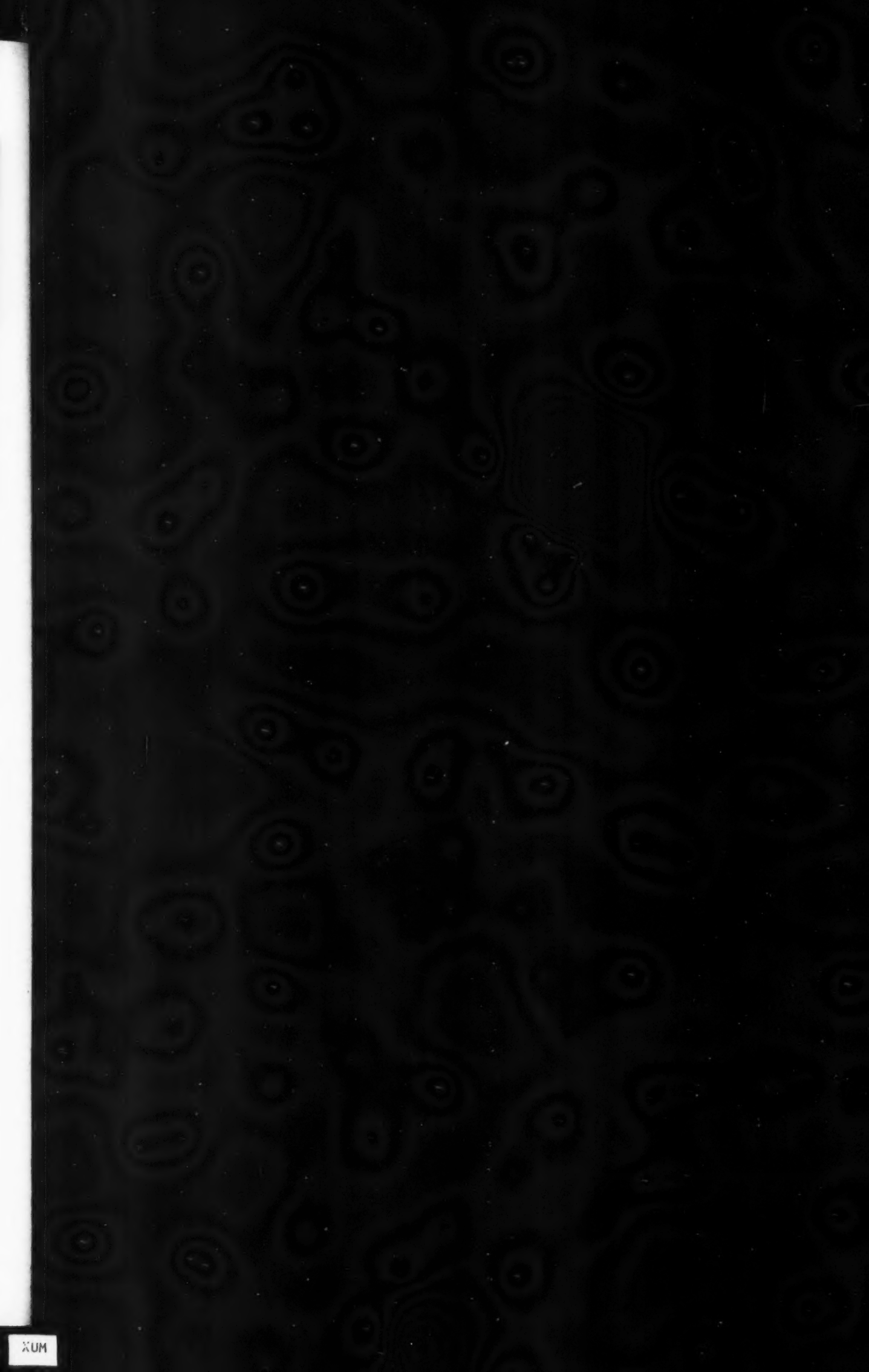
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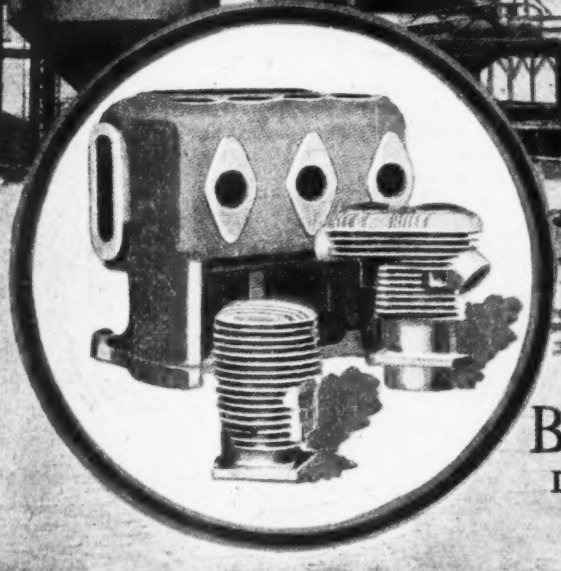

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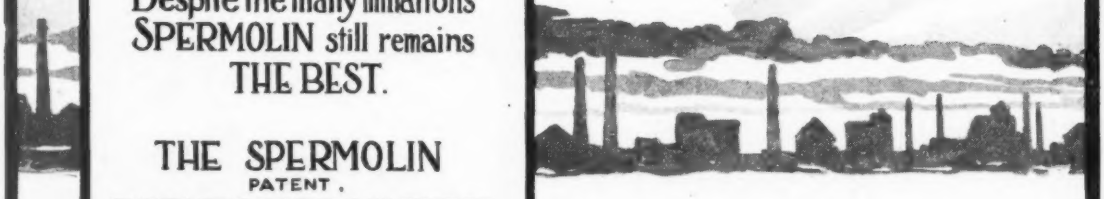

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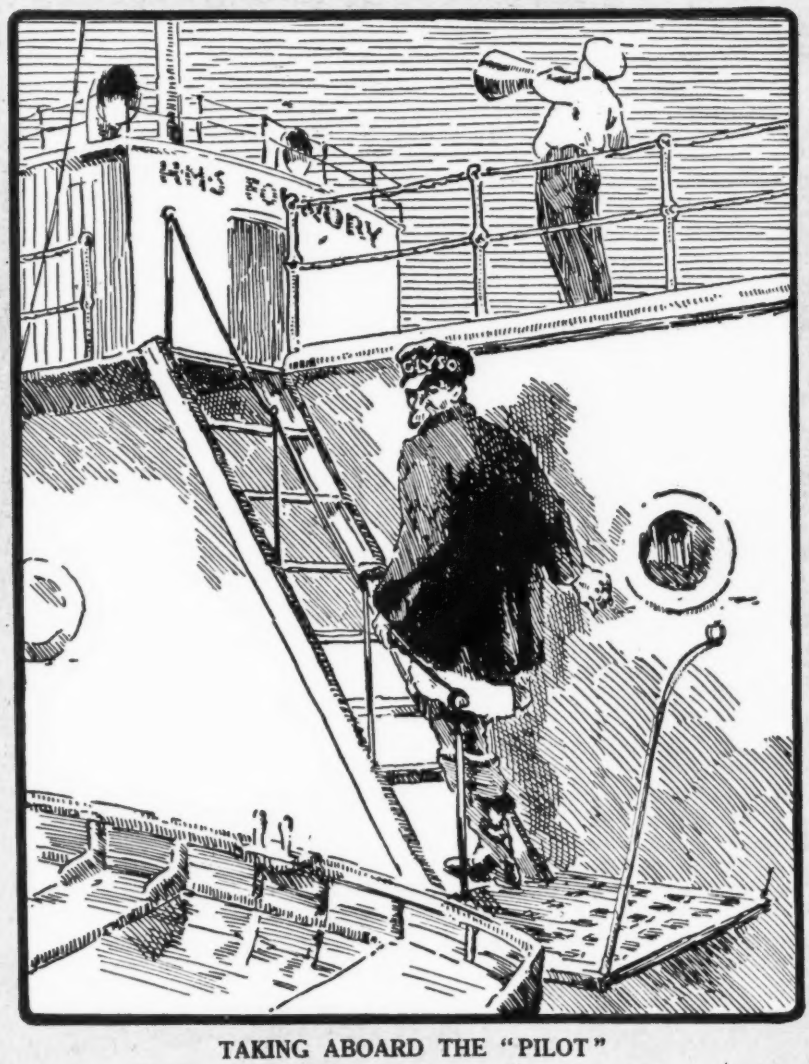

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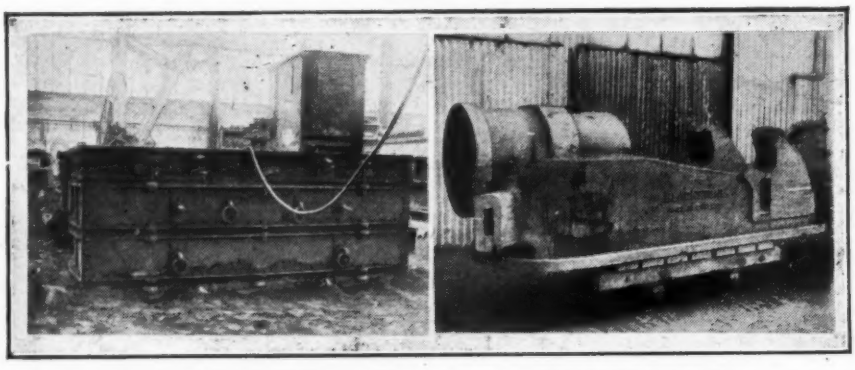

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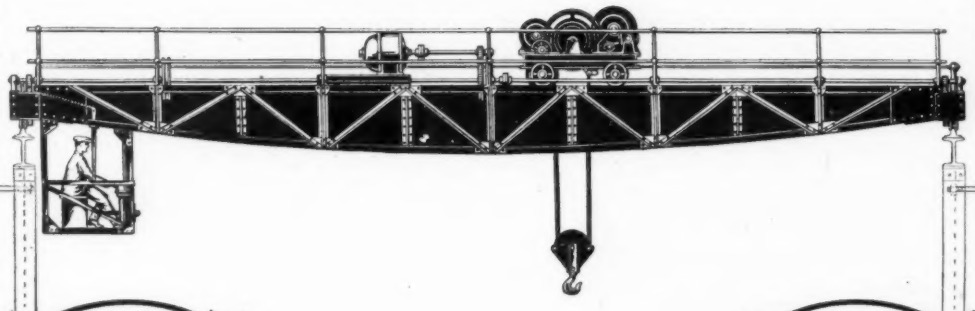

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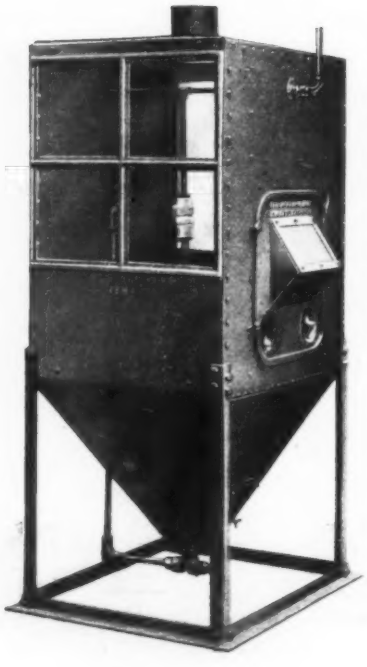

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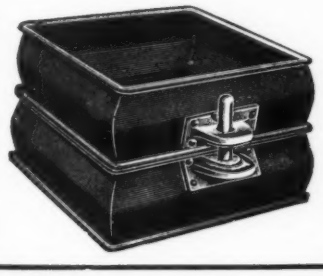

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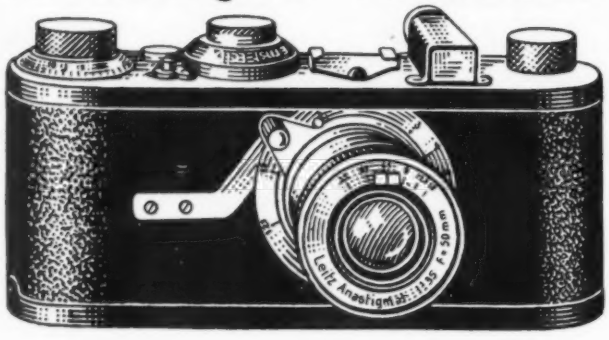

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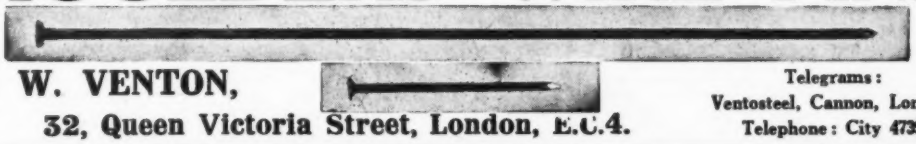

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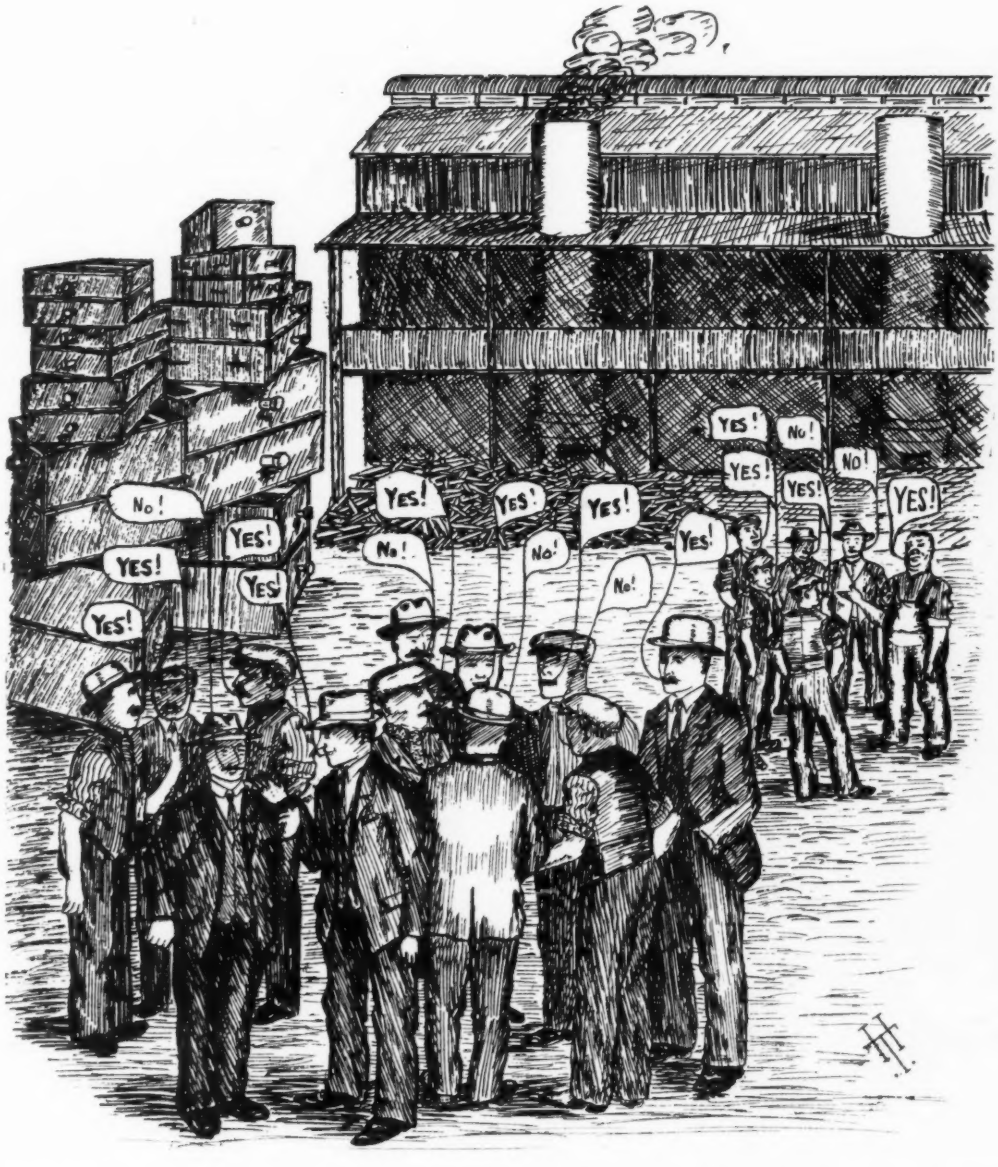

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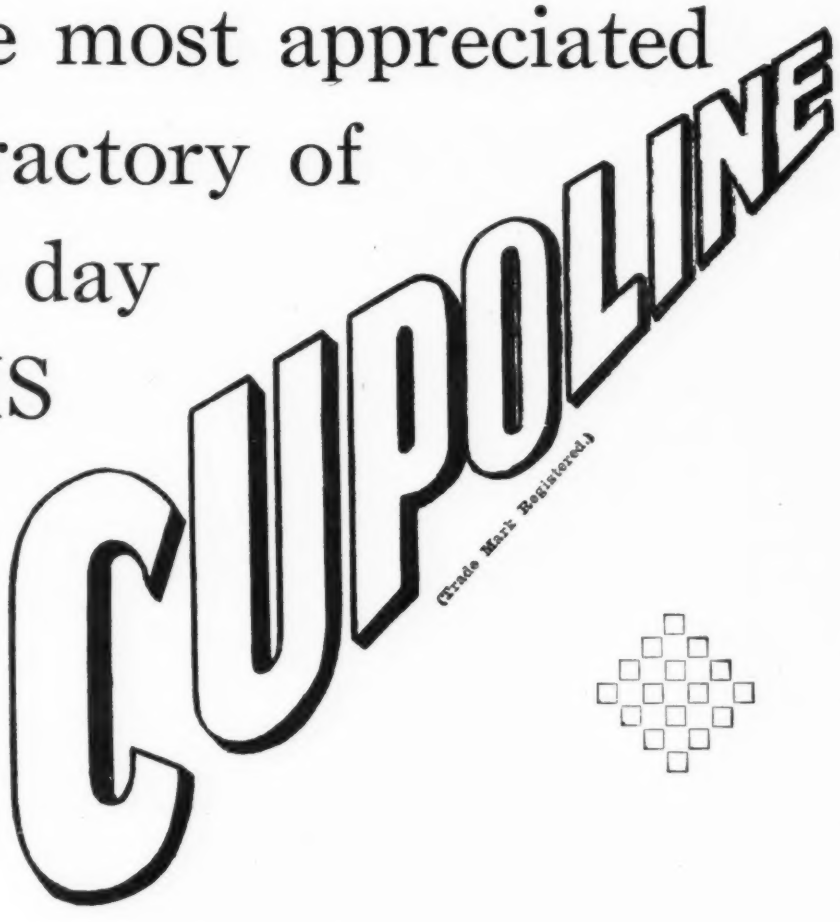

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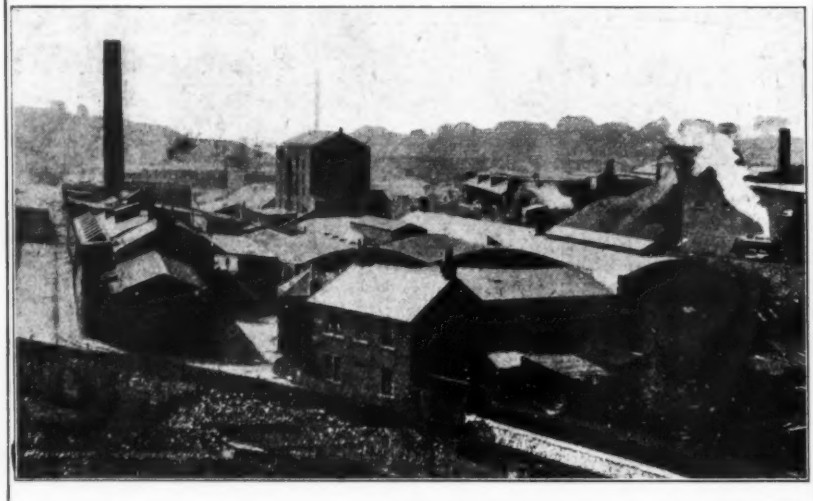

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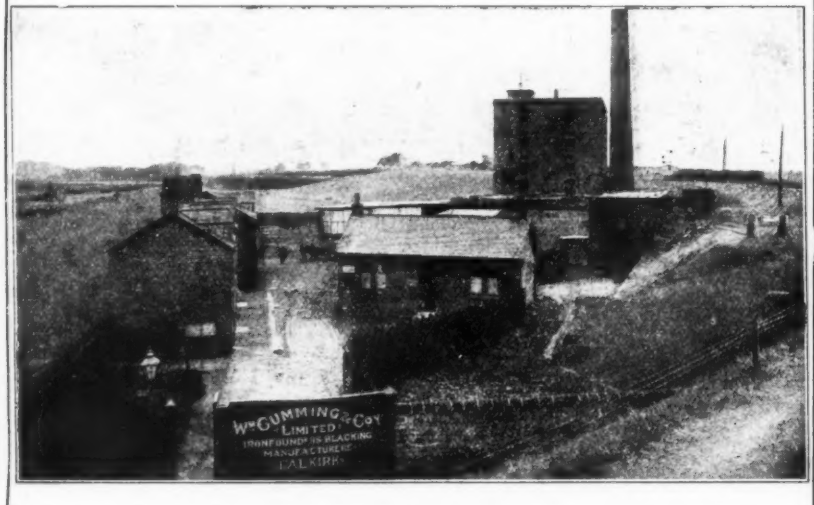

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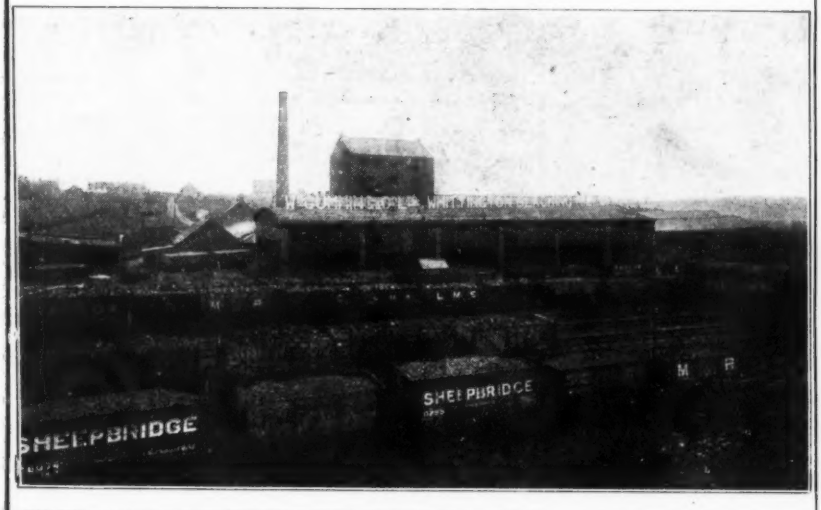

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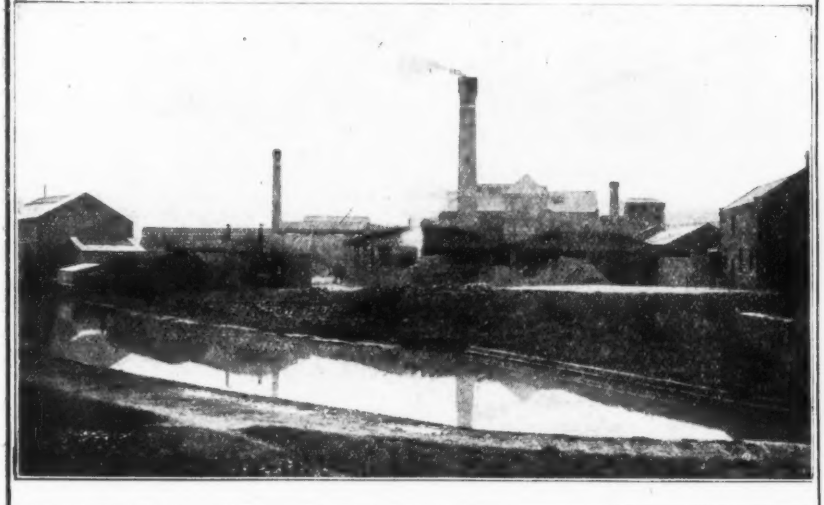

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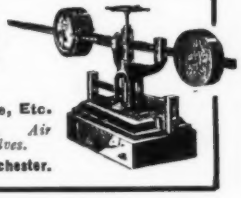

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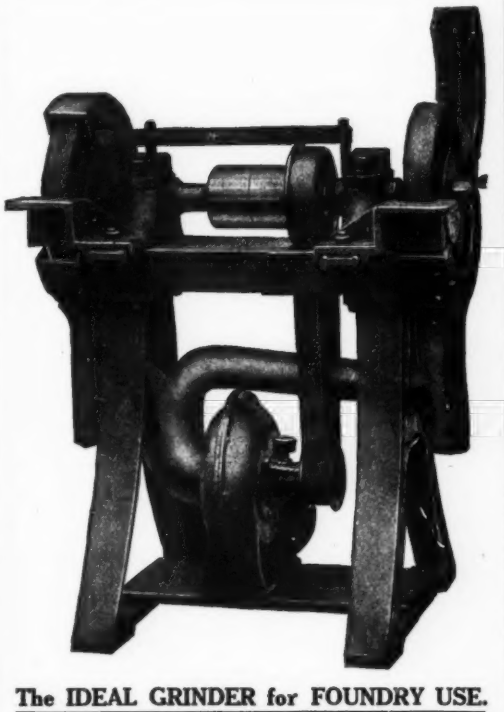

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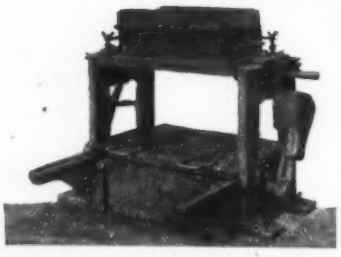

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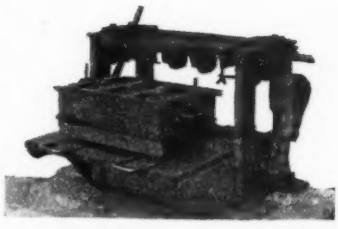

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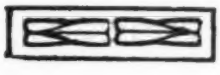

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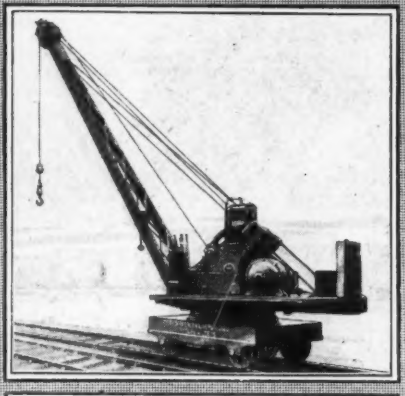

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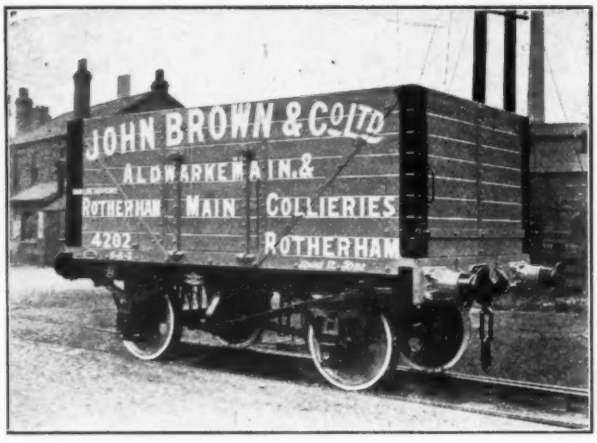

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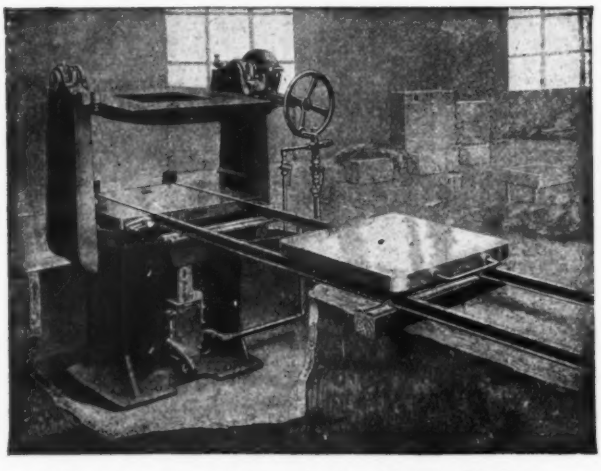

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